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Proposed Aerial Passenger Cableway Across the Whirlpool, Below Niagara Falls

Concessions were granted to a Spanish company by the Canadian Government, on Nov. 17, 1913, for the construction of a passenger aërial cableway over the Whirlpool, situated about six miles below Niagara Falls, on Canadian territory. The design and scheme of operation of the cableway will be similar to that of the system which connects the two mountain resorts on Mt. Ulia, near San Sebastian in Spain (ENGINEERING NEWS, July 22, 1909, p. 88) and similar in purpose to the much bolder project which climbs the first stage (a rise of 1370 ft. in a horizontal distance of 1191 ft.) of the Wetterhorn ascent, in the Berner Oberland, Switzerland, described in the same issue of ENGINEERING NEWS.

The Whirlpool system will be constructed on a somewhat larger scale than that of Mt. Ulia. The car on the latter had capacity for but 14 passengers while the former can transport 50 passengers at a load. The termini of the line are about 1770 ft. apart and are at the same elevation—about 250 ft. above the Whirlpool. The car has been built in Bilbao, Spain, and is there at the present time. It is believed that the actual construction work in Canada will commence in March, 1914. The cost is estimated at $120,000.

The system in general will consist of one car drawn back and forth across the Whirlpool, traveling on six 1¼-in. cables and hauled by another. A set consisting of three cables is placed on each side of the car. Should one cable break, the car would be carried by the other five. As a further safeguard in the event of a cable parting, all the cables are outside of the car.

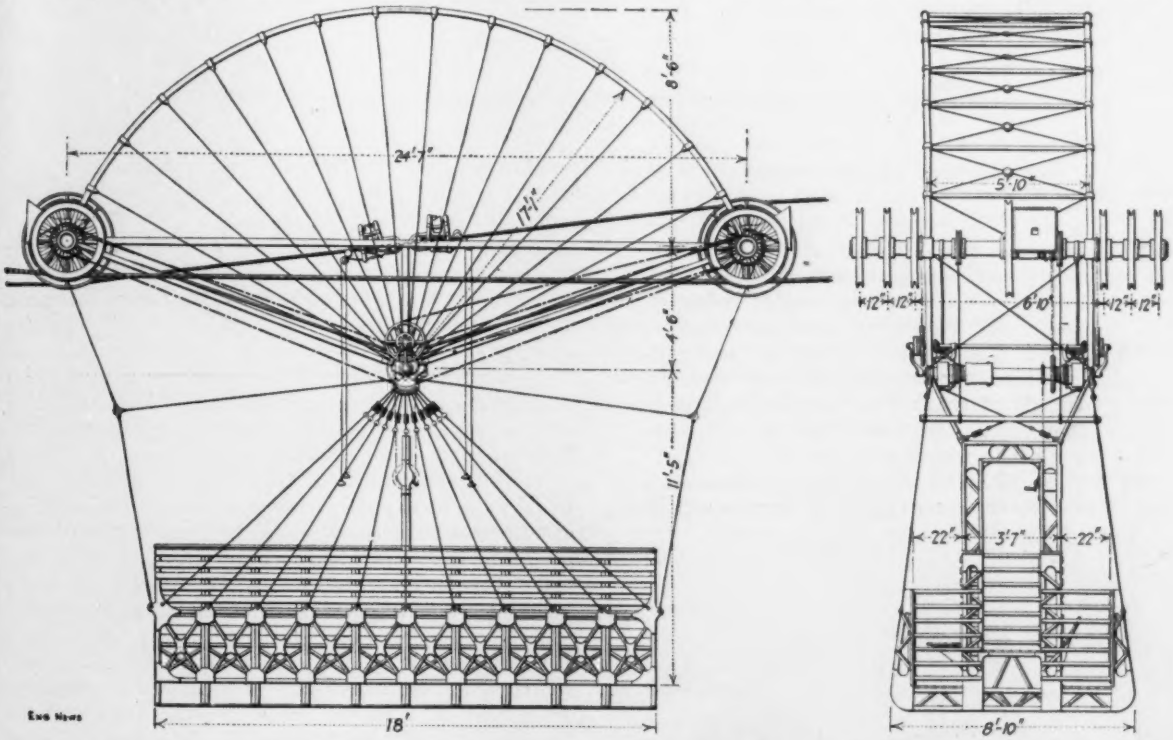

FIG. 1. SIDE AND FRONT ELEVATIONS OF THE 50-PASSENGER CAR FOR WHIRLPOOL CABLEWAY

Each cable will be attached separately to a fixed anchorage at one station and, at the other station, pass around a sheave to a counterweight. As the cableway is balanced by the counterweights, the weight of the car does not increase the tension in the cables, although an increased car weight (due to passengers) will, of course, increase the deflection of the cables. The counterweights are designed to prevent a stress in the cables which exceeds one-third their tensile strength. An endless cable, counterweighted at one end and driven by a motor at the other station, hauls the car.

The side and front elevations of the car are shown in Fig. 1; its dimensions are 18x8.8 ft. in plan. The car is carried on 12 metal-spoke sheave wheels (six per axle).

On each axle also, there is a tractor wheel, along which runs the hauling cable. The drawing shows that the body of the car is suspended by means of a system of wires, in tension, which radiate from a curved frame whose upper and lower members are of metal tubing.

Swinging is prevented by wires which connect the car body to the two upper and one lower axles. The supporting wires from the lower axle are each provided with a turnbuckle for regulating its tension. The direction of travel is determined by means of a controller, acting through sprocket chains to single-direction jaw clutches upon either axle. Brakes are installed; and, in the event of the car being stalled, a safety car will be provided for running out on the line. Fig. 2 is an elevation of the system and shows the deflection of the cables, due to the car, empty and loaded, respectively.

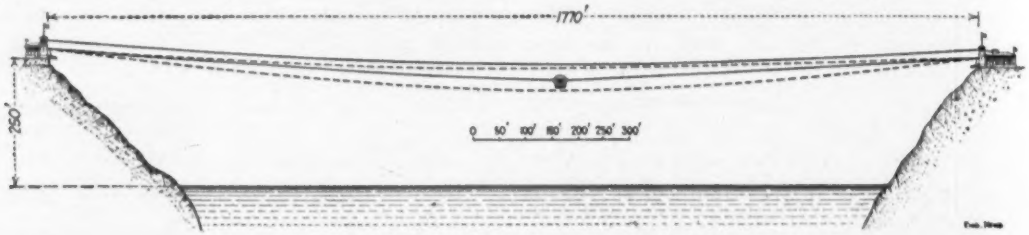

FIG. 2. ELEVATION OF THE WHIRLPOOL CABLEWAY, SHOWING THE DEFLECTION OF THE CABLES DUE TO LIVE-LOAD

Figs. 3 and 4 are views of the similar system of Mt. Ulia in Spain. Fig. 3 shows the cable connections at one of the termini. The counterweight of the hauling cable is visible; while the six carrying cables are seen, stretching at an angle of about 45°, from the pulleys to the concrete anchorage. Fig. 4 shows the appearance of the 14-passenger car in transit.

The designer of the system is Leonardo Torres y Quervedo, Chief Government Engineer of Bridges and Roads,

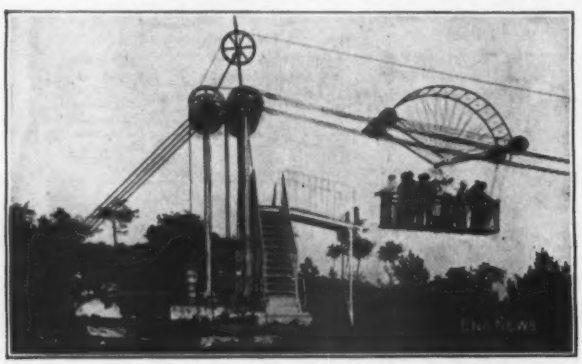

FIG. 3. A TERMINUS OF THE PASSENGER CABLEWAY AT MT. ULIA, SPAIN

Bilbao, Spain. The company which proposes to do the work is the Estudias y Obres de Inginierio, of Bilbao, and its President is Victor Gorbena, Chief Engineer of the Port. Negotiations were carried on between the Company and the Canadian Government by the E. G. Spilsbury Engineering Co., of New York City.

Latest reports state that the engineers who will have charge of the erection work in connection with the Whirlpool cableway are about to embark from Spain for New York and that work will start on scheduled time.

The Moffat Tunnel as a Denver Municipal Project

An unique case of a railroad and a city coöperating for the mutual improvement of transportation facilities and water-supply is seen in the recent agreement between the City of Denver and the Denver & Salt Lake R.R. Co. Incidentally this is an interesting development in the affairs of the Denver, Northwestern & Pacific Ry. (the "Moffat Road") which has been succeeded by the D. & S. L. R.R.

As noted in ENGINEERING NEWS, Mar. 9, 1905, the Denver & Salt Lake Ry. has been built and is operated from Denver to Steamboat Springs, Colo., and is to be eventually extended to Salt Lake City, Utah. The line at present crosses the continental divide at Rollins Pass, but one of the original projects of the line is to replace this with a tunnel under James Peak, to be 2.7 miles long at an elevation of 9930 ft.

On the line of this road, just west of the continental divide, is a saucer-like basin of some 200 square miles area, in which are the head waters of the Grand River. This drainage area naturally has held out interesting possibilities to the city of Denver, in its need for additional water-supply and it now shows its willingness to cooperate with the railway company in pushing this tunnel project for both tracks and conduit.

On May 20, 1913, the City and County of Denver, at a special election, adopted an amendment to its charter whereby a tunnel commission was created, made up of J. C. Helm, C. M. Willcox, and J. E. Fleming. Authority was conferred on the commission to build and to operate, or dispose of, a tunnel, to be known as the "Moffat Tunnel," and necessary approaches through the main range of the Rocky Mountains under or near James Peak for transporting water and electricity and freight and passengers.

One of the first acts of the tunnel commission was to appoint an engineering board, composed of D. W. Brunton, J. Vipond Davies and John W. Finch, to locate the tunnel and necessary approaches, to approve or disapprove of the location and grant secured by the Continental Tunnel Ry. Co. from the U. S. Land Office, to report on the probable cost with an inside clearance not less than 16 ft. wide and 21 ft. high, so that it may be suitable for a one-track road and for the conveyance of water and electricity, to report the length of time within which the tunnel might be constructed, ready for operation, etc.

A report of this board of engineers was made in November. It first concurs in the conclusion arrived at by Prof. R. D. George, State Geologist of Colorado, in his

report to the Tunnel Commission, "that the geological features are very satisfactory." Prof. George's report states that there is no reason to expect anything but continuous gneiss rock on the line of the tunnel. It will hold its form without internal lining under normal conditions. It is expected, therefore, that the tunnel will be of bare rock without lining, except in small lengths where some local conditions may be less favorable.

The engineers named studied the three locations considered: (1) at 9930-ft. elevation where a tunnel 14,256 ft. long would save 1730 ft. elevation and 8.3 miles of line; (2) at 9170 elevation, where a tunnel 21,800 ft. long would save 2190 ft. in elevation and 16.5 miles of line; (3) at an elevation of 9100 ft., where a tunnel 31,886 ft. long would save 2190 ft. elevation and 22.6 miles in line.

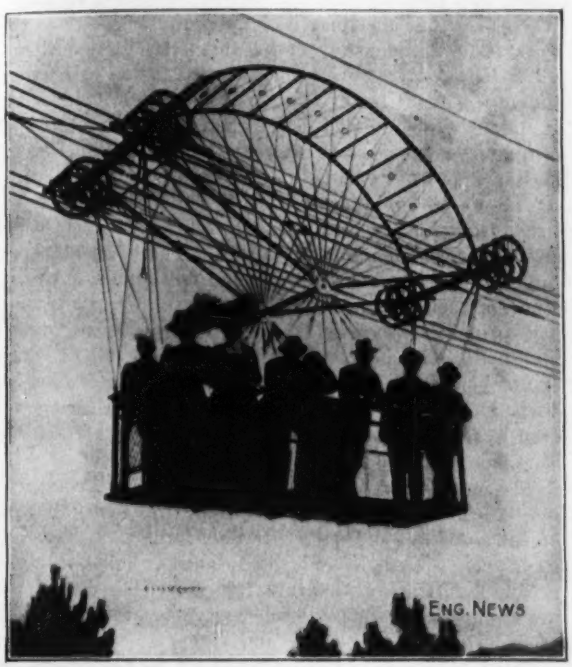

FIG. 4. THE 14-PASSENGER MT. ULIA CAR IN TRANSIT

The third project was unanimously favored because of its greater saving in elevation and line, because of the greater drainage area and larger water-supply available at the western portal, and because of the severe climatic conditions above 9100 ft.

The Engineering Board estimated the probable cost, with approaches, at $4,420,000 under normal conditions. Unforeseen contingencies, they warned, however, might increase this figure by up to $400,000. They believed that the actual tunnel driving would require three or 3½ years, with four years from beginning the preliminary work to operation of the railroad.

The agreement between city and railroad orders the Tunnel Commission to proceed with the undertaking if the estimated cost is $4,500,000 or less. The Commission is to pay $3,000,000 raised by city and county 5% bonds, redeemable in 50 years or after 5 years (at 102 plus accrued interest) and carrying 1% sinking fund.

The actual issuing of these bonds has yet to be ratified by another special election of the Denver taxpayers. If the project then fails of approval, the expenses incurred for the Board of Engineers is to be paid one-third by the railroad and two-thirds by the Tunnel Commission. If the bonds are approved these expenses are counted as part of the cost of construction.

According to the agreement, the railroad company pays the entire excess cost above the sum of $3,000,000.

Other sections of the agreement provide that the railway company may purchase this tunnel at any time for transportation purposes upon the payment of the $3,000,000 of bonds provided for by the city or such part as may be sold, together with all accrued interest. Purchase must be on or before maturity of the bonds. Then, the road's title shall be subject, however, to perpetual easement of the city and county for the transmission of water and electricity, and subject to the perpetual right of the city and county to have the tunnel, and approaches, tracks and equipment for 30 miles east of the eastern portal and 75 miles west of the western portal used by other railroad companies.

The railway company agrees to deposit its smaller share of the estimated cost of construction so as to be available concurrently with the larger share deposited by the Tunnel Commission. The title to the tunnel and approaches is to be vested in the city until the property has been purchased and fully paid for by the railroad company.

The railroad company is to pay the interest on all of the bonds issued and sold by the city, plus 1% for retirement, of the bonds outstanding to comply with the sinking-fund provision. The railroad bears the entire cost of maintenance, equipment and operation.

The trackage rights for the use of the tunnel and approaches by other railroads are to be under fair and reasonable trackage agreements, containing the usual proper and reasonable requirements and conditions. All other railroads desiring to use this tunnel may do so only on payment of 2½% interest upon the actual cost of its construction and equipment, together with a fair proportion of the cost of its maintenance and operation.

The railroad is to furnish all electric current necessary for the operation of the tunnel and approaches, but the transmission lines, tracks and permanent appliances for using electricity are to be a part of the tunnel cost and paid accordingly. The railroad is to furnish all the equipment required, including motive power. Any railroad having acquired trackage rights for the use of the tunnel, as above noted, may use the facilities of this company, provided it shall pay 3% interest on the reasonable cost of reproducing the track used at the time of acquiring the right-of-way, and in addition such a percentage of the actual cost of its maintenance and repair as the number of car wheels on the roads using it shall bear to the total number of car wheels passing over it.

Further than this, the railroad agrees, immediately on the beginning of work for the tunnel, to proceed in the construction of its line from Craig, Colo., toward Utah and within five years after completion of the tunnel to have its line constructed through the Uintah Valley, Utah, and in regular daily operation to Salt Lake City for through freight and passenger service.

Any mineral veins or deposits that may be discovered during the construction of the tunnel are to belong to the city and county exclusively.

Buenos Aires and Some Minor Argentine Ports

By F. Lavis*

SYNOPSIS—The commerce and harbor facilities of Buenos Aires, Rosario, Bahia Blanca, and Santa Fé, in Argentine Republic, are described. Some details are presented of the port works at Buenos Aires, as completed and under construction.

The City of Buenos Aires, besides being the commercial center of the Argentine Republic, is the seat of the Federal Government and its limits are coincident with

FIG. 1. MAP OF ARGENTINA SHOWING THE MAIN PORTS

those of the Federal district. Its population is about 1,350,000 approximately one-fifth of the total of the whole country. The Province of Buenos Aires has a population of about 1,900,000, so that the city and province together contain almost half of the total population (about 7,000,000) of the Argentine.

In Fig. 3 is shown an outline of the existing port and the proposed extensions of it. It is not over 25 years ago that vessels anchored off the city in the "River Plate" almost out of sight of the shore, and passengers and cargo were transferred in small boats and lighters. In the late eighties, during the time of the "big boom," the South Basin was built at the mouth of the Riachuelo, a small river forming the southern boundary of the city. Docks 1, 2, 3 and 4, together with the North Basin, sometimes known as the Madero Port, were built in the nineties (put into service about 1900) by Messrs. C. H. Walker & Co., of London, Eng., who are also the contractors for the present new extension.

Notwithstanding that the present quite large port facilities were only completed as late as 1900, the port has been very much congested for several years past, and the difficulty of doing business and frequent long delays to shipping have greatly increased the costs of handling both the imports and exports which pass through it. About two years ago the contract was awarded to Messrs. Walker for the construction of the new extension and this work is now under way and being pushed forward rapidly. The contract price, on the basis of the original estimates of quantities, was about $25,000,000 gold, but it is already evident that this will be considerably exceeded, owing to changes made to meet the demands of the almost phenomenal growth of the commerce of the city.

The wealth of the Argentine is derived almost entirely from its agricultural and pastoral products which are exported principally to Europe. There are no manufactures owing to the scarcity, or in fact almost entire absence, of fuel, minerals, or structural timber of any kind. The principal products are cattle, sheep, horses, wheat, maize, linseed, quebracho logs and extract, all of which, except horses, are exported in large quantities. The imports include everything necessary to a prosperous and even wealthy community which are products of factories, workshops, mines, or of the Arts and Sciences.

The most generally developed section is that comprised in the province of Buenos Aires, and the southern parts of the provinces of Santa Fé and Cordoba. These sections were originally devoted almost wholly to cattle raising but since agriculture has proved so much more profitable, the estancias (ranches), over which formerly ranged thousands of cattle and sheep, are being broken up into smaller holdings and devoted to the production of cereals, while the cattle industry is being forced toward the North into the region of the so called Gran Chaco, western Paraguay and eastern Bolivia, and the sheep toward the southwest to Neuquen, Rio Negro and Chubut. The principal railway development so far has been by a series of lines radiating from Buenos Aires and, to a very much smaller extent, lines radiating from Bahia Blanca, Rosario and Santa Fé.

Besides Buenos Aires there are four other principal ports, La Plata, Bahia Blanca, Rosario and Santa Fé and numerous smaller ones from which much of the exports are shipped, but practically all the imports are brought to Buenos Aires. There have been efforts made to direct some of the business to the other ports but, as is almost invariably the case in the South and Central American countries which are dependent on the outside world for nearly all their manufactured products, the headquarters of the importing merchants and the principal banks become established at the National Capital when this is also a port and it is practically impossible to divert the current of business in imports else-

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wheat. In the Argentine some of the bulkier articles, which do not pay much, if any duty, such as coal and lumber, and which are shipped in cargo lots, are taken directly to the other ports which are more convenient points of distribution, but over 70% by weight and 80% by value of all imports come to Buenos Aires and 55% by volume and 60% by value of the total water-borne traffic of the Argentine passes through this port.

The total value of the exports during the 10 years 1900-1910 increased from about 150 millions of dollars, gold, to about 350 millions, the imports increasing at a similar rate and averaging about 50 millions less per annum. The relative values in millions of dollars, gold, of the principal items of export for the year 1910 (the last year for which complete statistics are available) being, approximately, as follows: wheat, 70; maize, 60; linseed, 45; oats, 10; quebracho, 10; beef and mutton, 35; wool, 60; hides, 45. For comparison it may be noted that the traffic of the Port of New York is doubled every twenty years, while at the present rate of increase it is probable that that of the Port of Buenos Aires will be double in less than ten years.

The method generally used in the United States of handling the cereals, wheat and maize, etc., by means of elevators, and its transport in bulk, has never found favor in the Argentine. Most of the grain is put up in sacks

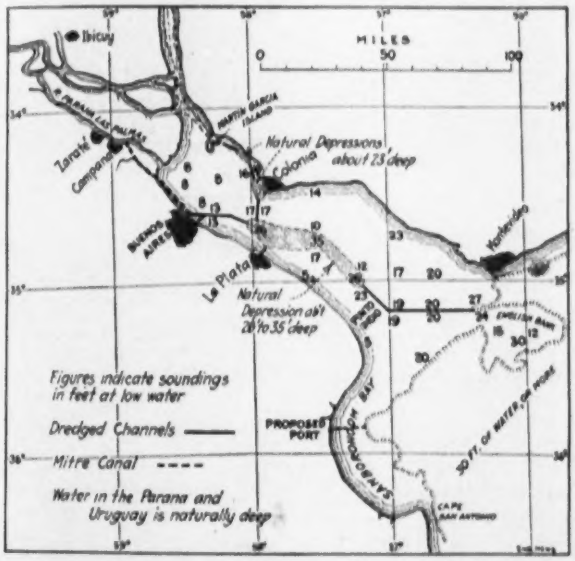


FIG. 2. MAP OF THE MOUTH OF THE RIVER PLATE

and transported in them to the ports. The overseas shipments are made partly in sacks but principally in bulk, the bags being opened as the cars are unloaded at the ports. This is done sometimes by slitting the bags right over the hatchway of the vessel, sometimes at the head of a chute leading from the car down to the hatchway and in other places the car is placed over a hopper through which runs a belt conveyor, the bags being slit at the car door and their contents dropped through the hopper onto the belt and so conveyed into the hold of the vessel. Mechanical appliances are not in general use in the Argentine in spite of the high cost of labor, which is even, on the whole, somewhat higher than it is in the United States. There are elevators at the ports of Buenos Aires, Bahia Blanca and Rosario but none at interior points, these elevators at the ports being only used for storage, to facilitate the unloading of cars when ships are not immediately available or ready, and to facilitate and expedite the loading of these latter.

All along the Parana River, as far up as Santa Fé, there are numerous places with deep water close to the shore, and a high bank rising almost perpendicularly from it, where ocean-going vessels are loaded. A spur from the railroad is run along the edge of the top of the bank, the vessel is moored alongside and directly below, and the bags are shot down by chutes to the side of the hatchway where they are either slit open and their contents loaded into the hold, or the cargo is shipped in the sacks. Probably 25% to 30% of all the maize exported is loaded in this way, which is cheap and expeditious.

There have been numerous projects for the installation of elevators along the railroad lines but for various reasons they have never been adopted. One reason that is given is the desire on the part of each individual owner to get his own grain to the buyers at the ports, and a general distrust of any system of payment based on grading at the elevator. Then the Argentine differs from the United States, inasmuch as by far the largest proportion of its grain, especially maize, is exported instead of being consumed in the country. The climatic conditions also are not severe as they are in the United States, there being little if any frost north of Bahia Blanca. In connection with the installation of machinery also, there must always be considered the lack of a plentiful supply of good machinists and men with mechanical training. Most of the immigrants come from southern Europe, where machinery is not in such general use as in the North and in the United States.

THE PORT OF BUENOS AIRES

Buenos Aires is situated on the southerly side of the Rio de la Plata, generally known among English-speaking people by its corrupted title of the "River Plate" (Fig. 2). This is really an estuary rather than a river and into it are emptied the vast volumes of water brought down by the rivers Parana and Uruguay. The former is one of the great rivers of the world, its sources reaching almost to the Atlantic seaboard near Rio de Janiero and interlocking with those of the Amazon all the way around to Bolivia. Both the Parana and Uruguay are heavily silt bearing so that on account of its great width the Rio de la Plata will probably always present a problem in dredging. Fig. 2 shows the general conditions as to depth of water, the location of the dredged channels, etc.

In the rivers Parana and Uruguay, above the Rio de la Plata, there are quite generally depths of from 50 to 90 ft. all the way to Santa Fé on the former and to Conception del Uruguay on the latter, except for certain but not numerous shallow bars which require dredging to maintain the requisite depth.

The water of the Rio de la Plata is, under ordinary circumstances, practically fresh at Buenos Aires and above, and salt at Punto Indio. There is a natural rise and fall of the tide of about 4 ft. but the height of the water is usually more affected by prevailing winds than the natural tidal conditions. The result of the combination of wind and tide has been, on one or two rare occasions, to cause variations of as much as 6 to 8 ft. both

above and below zero, though the time during which the tide has been below the established zero or mean low water, has been less than 5% of the total, and the time during which it has been more than 1 ft. below zero less than 1% of the total. The bed of the river is soft, sandy mud; soft enough to allow boats to push their way through a depth of one or two feet of it.

Dredging is being carried on continuously by the Government, both to maintain and deepen the channels, some very powerful hydraulic suction dredges of the sea-going type being in service (Fig. 4D). In 1890, the maximum depth through the South Channel to the Riachuelo was about 19 ft. By 1903, after the new docks had been opened and the North Channel dredged to them, the depth had been increased to 22 ft. At the present time there is 25 ft. of depth available at any time, and it is expected that by the time the new docks are completed there will be a depth of 27 ft. available at all tides.

THE RIACHUELO, which is an estuary at the mouth of a small river along the southerly side of Buenos Aires, is the oldest part of the port and is now utilized for dock purposes for ocean going vessels on both sides for a distance of about two miles from the South Basin or Anti-Port. Here, along the north bank as well as along part of the south bank, most of the timber and coal is unloaded, and along the south bank there are three large frozen meat establishments, the wool market, etc. The construction is largely of wood and generally rather poor. It consists of a pile platform in front of a timber bulkhead, the latter of sheet piling tied back by anchors; there are no piers. In many places the bulkheads have entirely collapsed and the filling is continually leaking through, not only filling up the waterway but causing much unevenness in the surfaces of the street alongside. From 20 to 25% of the tonnage of the port is handled in this section, the vessels often lying three deep alongside the dock. There is a depth of 22 ft. in the Riachuelo below the zero or mean low water of the port.

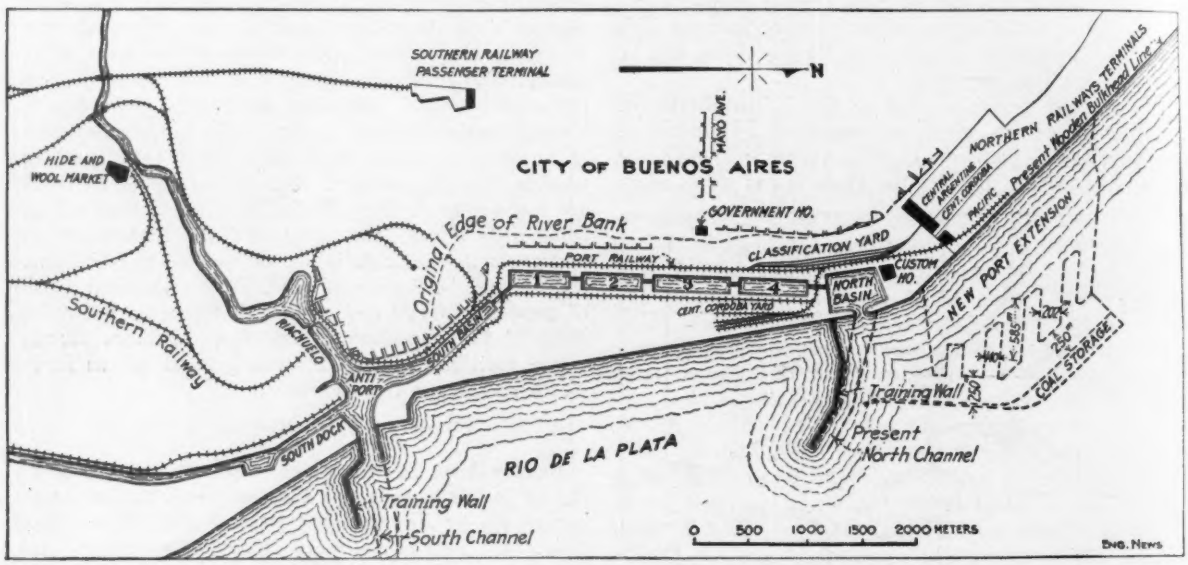


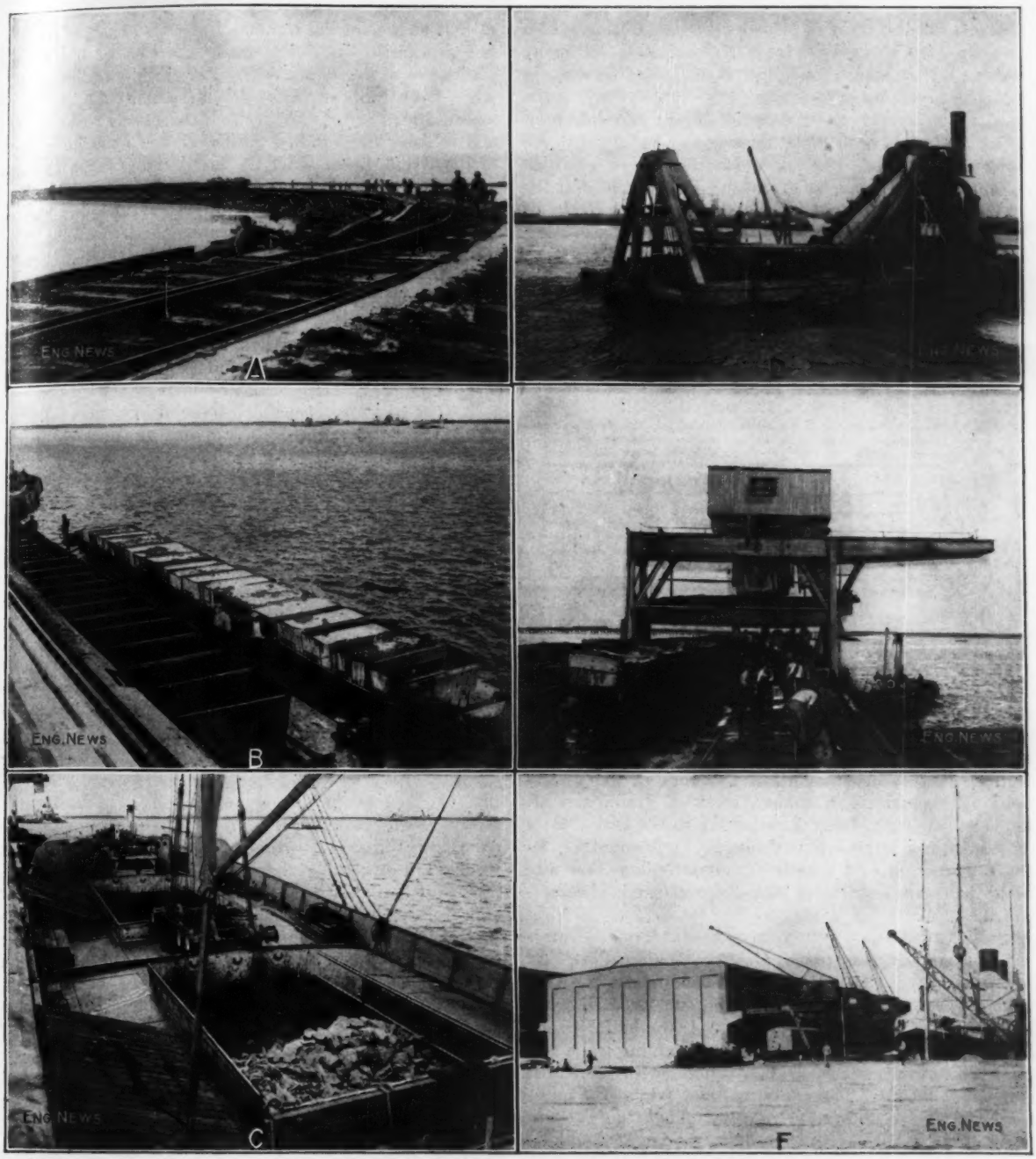
FIG. 3. THE PORT OF BUENOS AIRES SHOWING PRESENT AND PROPOSED STRUCTURES

The principal impediment to navigation is the Punto Indio bar situated at the end of the natural depression shown on the map and about 90 miles below Buenos Aires. The material here is very soft, necessitating extremely flat side slopes, probably somewhere near 1 in 100, and it is estimated that, approximately, 100,000,000 cu.m. will have to be removed to get the required depth. The combined output of the dredges at the present time is about 15,000,000 cu.m. per annum and the actual cost, omitting capital charges, is said to be about 4c. gold per cu.m. The amount of merchandise passing through this channel at the present time is estimated at about 19,000,000 tons annually and it is probable that by 1917, the proposed date of completion of the Port Works, it will be about 25,000,000 tons, approximately, equal to the traffic through the Suez Canal.

The port of Buenos Aires, as it exists at present, may be divided into three parts, the Riachuelo, the Anti Port and South Basin, the new docks and North Basin (Fig. 3). It is entirely under the control and supervision of the National Government and operated by the ministry of Public Works.

THE ANTI PORT AND SOUTH BASIN is of more modern construction, having been completed about 1890; the construction is mostly of timber platform with stone-pitched slopes instead of bulkheads. This has a total dock frontage of about 1½ miles, two-thirds of which, on the side of the South Basin next to the city, is used by the river and coastwise traffic. There is quite a large passenger traffic by comfortable side-wheel passenger boats, up the Parana to Asuncion in Paraguay, to Concordia in Uruguay, and intermediate ports along both rivers, and by two different lines and three or more steamers every night to and from Montevideo.

The east side of the South Basin is devoted almost entirely to the coal business, except at the extreme southerly end of the point which is occupied by the Port Works



A. Timber trestle used in making new bulkhead.
B. Lighters with loaded and unloaded buckets removing dredged material.
C. Vessels bringing in stone for port work.
D. Type of dredge used in port work.
E. Bucket unloader for handling buckets shown in B.
F. New docks, showing shipping cranes and type of warehouse.

FIG. 4. VIEWS IN THE PORT OF BUENOS AIRES

department. The dock at the southerly end of the Anti Port belongs to the Southern Railway and has now nearly a mile of dock frontage. Considerable difficulty has been experienced at this dock, which has masonry walls, on account of bad foundations, the walls having been pushed out in some places. The new walls have been built on concrete cylinders sunk well into the "tosca," a sort of indurated clay or clayey shale which underlies practically the whole of the great Argentine plain at varying depths below the surface covering of soil. The traffic handled in this second section of the port, that is, the South Basin, Anti Port and South Dock, amounts to about 1,500,000 tons annually, the depth of the water being about 23 ft.

Lighters are used to a considerable extent throughout the port, both for loading and unloading cargo. There are three railway terminals on the upper part of the Riachuelo, above the part navigable for ocean-going

steamers, where grain is loaded into lighters and taken alongside the steamers. It is claimed that for many reasons this is more economical than unloading directly into the vessels as it does away with much delay to the cars, which are in great demand during the season in which the crops have to be moved, and vessels that are lying on the outside tier can be loaded, or a vessel which is being loaded on one side from the dock, can load at the same time from a lighter on the other side. Grain in bags is often used also to fill out the cargoes of the regular mail boats, and is also shipped in lighters from some of the river ports to Buenos Aires for vessels loading partial cargoes there.

Coal is handled by ordinary 3- to 5-ton cranes and often rehandled several times afterwards, there being no installations of the mechanical unloading and storage

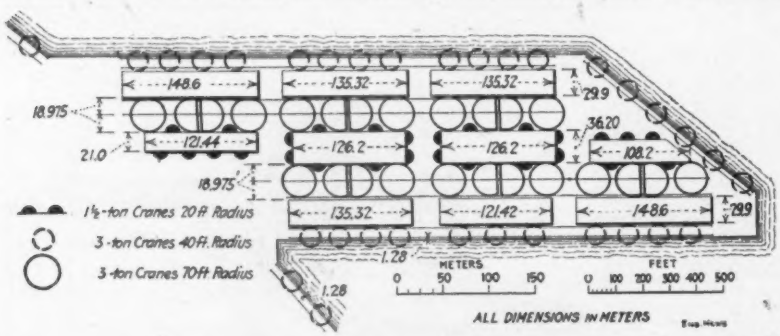


FIG. 5. PLAN OF PIER IN NEW PORT EXTENSION OF BUENOS AIRES, SHOWING ARRANGEMENT OF BUILDINGS AND CRANES

appliances in such general use in the United States. Quite a large proportion of all the work in the port is done by manual labor, timber, sacks of grain, and all kinds of packages being handled on men's backs, as is done also to a large extent throughout the country. In the construction of the railroads, it is seldom that any other tools are seen than picks, shovels and wheelbarrows.

THE NEW DOCKS AND NORTH BASIN form the present modern port, sometimes called the Madero Port. As previously noted this work was completed about the year 1900. The docks, of which there are four, are each about 500 ft. wide and 2000 ft. long, and are built in the European style with granite masonry retaining walls and tidal locks at the ends where they connect with the North and South Basins. They are numbered 1 to 4, the numbers running from south to north. These docks have 24 ft. of water but, owing to the construction of the locks, at mean low water can only admit vessels drawing 22 ft. The lock between the North Basin and Dock 4 is shown in Photo. 239, the view being taken looking toward the latter. The width of this lock is 83 ft. and that of the passages between all the other docks, and that between the lower dock and the South Basin, is only 66 ft. so that the regular mail boats, which ply between Europe and Buenos Aires, can only use the upper dock, and some of the latest and largest cannot do this but have to remain in the North Basin. There is a row of three to four-story warehouses along the three upper docks on the side nearest the city, and on the outer side of dock No. 4, there is a double row of warehouses, Fig. 4F, all fitted with fixed cranes for handling the merchandise. All the docks are fitted with traveling cranes, similar to that shown on the right in Fig. 4F. The grain business is carried on mostly along the east or outer side of the two center docks, where the grain elevators and a large flour mill are located, and where also grain is loaded directly from the cars into the vessels. Shipments of live stock are handled mostly at the lower dock next to the South Basin. All the merchandise, with the exception of the bulk freight, principally coal and lumber, is handled at these docks and stored in the warehouses pending examination by the customs, and clearance. The warehouses are mostly of reinforced concrete, though some of the older ones are of brick. Stone and sand are both brought from Uruguay, the only building material found or produced in the Argentine, within any reasonable distance of Buenos Aires, being bricks of a fair common quality. All the stone and sand used for building purposes in and near the city is unloaded at these docks, generally at the ends, and this amounts to nearly 1,000,000 tons per annum, the amount of the rest of the traffic handled at these four docks amounting to about 4,000,000 tons, and the total length of dock frontage being about 4 miles.

The mail steamers, of which, counting the regular lines and intermediate boats, there is generally one and often two or three a day, enter the North Basin and discharge their passengers and baggage there in front of the Custom House which is on the north side of it, then move into the upper dock to discharge and receive their cargo, returning to the North Basin on the day of sailing to receive their passengers. They usually stay in port from 7 to 10 days, the principal lines, most of which have weekly sailings, being the Royal Mail, Hamburg-American, North German Lloyd, Holland American, Lamport and Holt, the latter with a line to New York direct as well as England, and at least as many more European lines, some running fast steamers, making the run from Barcelona or Marseilles in about 14 or 15 days. There are several mail steamers of from 15,000 to 20,000 tons burden.

Summarizing the above, the extent of the dock frontage and the traffic of the present port are, approximately, as follows:

	Length, miles	Tonnage
Riachuelo	4	2,000,000
South Basin and Anti Port	2½	1,500,000
North Basin and Four Docks	4	5,000,000

The new docks were built on land reclaimed from the river which, in addition to the docks themselves, provided a strip some 700 to 1000 ft. wide between them and the original bank, and also the triangular piece on the outside, as shown on the map, which has a masonry retaining wall for about half its length along the river.

There are three classes of steamers using the port, the regular mail boats, the intermediate mail and cargo boats of regular lines, and tramp steamers. The largest mail steamers of the regular lines which now reach Buenos Aires have a draft when fully loaded of 28 to 30 ft. Most of them, however, have other ports of call both coming and going at which they discharge and receive cargo, as at Rio, Santos and Montevideo. Many of them also

coal at other places nearer Europe where, consequently, the cost is less and so they can usually count on arriving and leaving Buenos Aires with 3 to 4 ft. less draft than they require when fully loaded. These conditions are likely to continue so that with the provision of a 30-ft. entrance channel, vessels of this class 33- to 34-ft. draft can be accommodated. Tramp steamers, which are limited in size by harbor requirements all over the world and by the Suez Canal, seldom draw over 28 ft. and, of course, are fully loaded as a rule. The regular lines of cargo boats and intermediate mail steamers are mostly governed by the same considerations as the regular mail steamers, except that they can often afford to wait for the tide when they are fully loaded as they sometimes are, so that the provision of 30-ft. draft at mean low water in the channel is believed to be ample for all future requirements, at any rate so far as they can be foreseen at this time.

The docks are served by the Port Railway (5-ft. 6-in. gage), owned and operated by the Government, which also operates the docks. This connects at the lower end with the Southern Railway and through it with the Western, and at the northern end with the Central Argentine and Pacific, all of the same gage. The Western Railway will have a direct connection to the Port Railway at a point near Dock 2 as soon as its tunnel now under construction, under the Avenida de Mayo, is completed. The Central Cordoba Ry., a meter-gage line reaching the northern section of the country, has a temporary freight and interchange yard in the area of made land outside Dock 4. All freight from this line for export, has to be transferred to the broad-gage cars, for transfer to the vessels at the docks.

THE NEW EXTENSION—The docks now under construction, as shown by Fig. 3, lie to the north of the North Basin and in front of the terminals of the Northern Railways, the Central Argentine, the Central Cordoba and Buenos Aires Pacific. Their general dimensions are shown on the plans. Each of the piers, except the first one, is to have a triple line of warehouses, all plentifully supplied with cranes, as shown in detail in Fig. 5. They will be served by the Port Railway and, of course, have direct connection to the railways behind them. The present terminals of the Central Cordoba and Pacific Railways are on made land reclaimed from the river and held on the river side by a wooden bulkhead along the line shown on the map. The present improvement, as will be seen, will provide an area of new land about one mile long by one-half mile wide behind the docks, part of which will probably be used for sorting yards for the Port Railway and for the extension of some of the railway terminals, as plans are now under consideration for bringing the lines of the Entre Rios Railway and its connection through to Paraguay into the Central Cordoba Terminal, which must then necessarily be enlarged.

The docks are to be built with concrete retaining walls with granite facing above the water line. The section has not been definitely decided on but it will probably be, approximately, that shown in Fig. 6. The foundations and walls are to be built in the dry, the whole area of the piers and docks being divided into three sections, each of which is to be in turn surrounded by a dam and unwatered. As the top of the tosca which underlies the mud is well above (10 to 15 ft.) the bottom of the foundations in all cases, there will probably be little difficulty with this method of carrying out the work. A part of one of the timber trestles built along the line of the dams, and from which the material for the embankments forming them is being dumped, is shown in Fig. 4B. In the foreground the trestle has been wholly filled in and the partial filling can be seen in the middle distance. More than five million ft. b.m. of Oregon pine will be required for these temporary trestles. The first section, comprising the first two piers at the southerly end, is now under construction, the dam being far enough advanced so that it is expected to be able to start some of the masonry by the early part of the next year. The timber trestle for the dam for the second section is well underway and will take in the third pier. The contract calls for the completion of the work by the end of the year 1917.

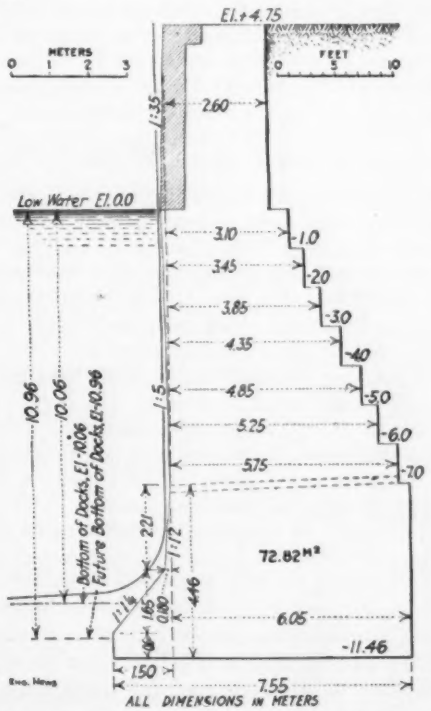


FIG. 6. CROSS-SECTION THROUGH DOCK WALL, NEW PORT EXTENSION, BUENOS AIRES

The following partial list of some of the items, which are included in this contract, will give some idea of the magnitude of the work. These quantities are taken from the original contract and will likely be considerably exceeded:

Dredging and excavation	8,244,000	cu.m.
Dock walls 5.2 miles in length	360,000	cu.m.
Outer breakwater 2.6 miles in length stone facing	209,000	cu.m.
Sheds and warehouse floor area	432,000	sq.m.
Railways 5-ft. 6-in. gage	30	miles
Granite paving blocks	15,000,000	
Cranes for warehouses:		
3 tons 65 ft. rad.	68	
3 tons 45 ft. rad.	95	
1½ tons 20 ft. rad.	76	

The excavation of the Anti Port is now being done by powerful dredges, which, in addition to the surface mud, have also to dig some 10 to 12 ft. of the hard tosca. The dredge shown in Fig. 4D, usually handles 2000 cu. m. of the softer material in 10 hr. The material is placed in buckets or specially built lighters as shown in

Fig. 4B, which shows a lighter with empty buckets alongside the pier and one loaded just outside. The buckets are hoisted by the overhanging arm of the traveling gantry, shown in Fig. 4E, and dumped by tipping by the sprocket chains at the sides. The material now being dredged is used to build the dams around the sites of the piers. The buckets and cars hold about 5 cu.yd. each and there are 20 buckets on each lighter. Stone for the work is brought from the quarries of the contractors at Colonia, Uruguay, in steamers, of which there are six in use, all of the type shown in Fig. 4C.

Messrs. Livesey, Son & Henderson, of London, are Consulting Engineers to the contractors and the Argengentine Government on this work. R. D. Oldham is the Resident Engineer and their representative on the ground, and to his courtesy the writer is indebted for an opportunity to visit the works and to take the pictures which are here reproduced, as well as for some of the information contained in this article in regard to the new Port Works. G. A. Lange, M. Am. Soc. C. E., is Chief Engineer of the Ministry of Public Works under whose supervision the works are being carried out.

Other Argentine Ports

Rosario is the second city in importance in the Argentine, its population being something over 100,000. Its port is operated by a French company under a concession from the national Government and it is served by a mixed gage (5-ft. 6-in. and 1-meter) railway operated by the concessionaire. The port facilities consist of about 2½ miles of quay fronting along the river, mostly of timber platform construction with mattress and stone pitching for protection of the banks. The town is on the convex side of a bend of the river and, as the port follows along this bank, its situation is not altogether favorable. The trade of this port is principally exports of cereals and imports of coal and lumber. The exports for the past eight or ten years have fluctuated between one million and two and a half million tons per annum, the best year being in 1908 and the poorest 1911. The imports, mostly coal and lumber, have increased from about half a million tons in 1902 to over a million in 1911. It seems to be a general opinion that the exploitation of this port by a private company rather tends to retard its development.

Bahia Blanca, situated at the southwest corner of the province of Buenos Aires, is a city of about 50,000 inhabitants located about two miles back from the banks of a small river or estuary about 25 miles from the open sea. From it is shipped most of the wheat exported from the Argentine. The port facilities have been developed entirely by private enterprise, that is, by the railroads. The port of the Southern Railway, named Ingeniero White, consists of three piers, mostly of timber construction, with two large grain elevators, on the eastern and more modern pier, which has cast-iron piles and timber deck. About two kilometers west, that is, further up stream, is Port Galvan, recently built by the Pacific Railway, both of these ports being reached through a dredged channel about 12 km. in length. The pier at Port Galvin is a concrete structure founded on concrete cylinders sunk through the overlying mud into the tosca which is found here at a depth of 25 to 28 ft. below mean low water. The wells or cylinders are hexagonal in form and sunk in groups of three, each group facing alternately in opposite directions forming an interlocking series. They are sunk through the mud and from three to four feet into the tosca, dredged out, a concrete seal placed in the bottom and then filled with a lean mixture of concrete (about 15 to 1). The cylinders are built up in place as they are sunk and finished with their tops at high-water level, a continuous concrete wall being built above this, as is shown in Fig. 8. These docks are built to provide for an ultimate depth of 30 ft. at mean low water.

A port has been built by the Rosario Puerto Belgrano Railway Company at Port Belgrano, about 10 km. east of Bahia Blanca, close to the Government military port and near the natural deep water. This is a single granite pier with breakwater protection. Grain is unloaded directly from cars into the vessels, and also from the cars on to belt conveyors, which carry it along the docks to points where, by means of movable towers, it is diverted to any point of discharge. This dock has been bought by the Government and will eventually become part of the military port, making it necessary for the Rosario Puerto Belgrano Railway Company to find accommodations elsewhere, which it will probably do either near the city of Bahia Blanca and the ports of the Southern and Pacific Railways, or at a site some 3 km. east of Puerto Belgrano, where some work has already been done by a private company, working under the so called Pagnard concession. These docks are reached only by the three railroads named, all of 5-ft. 6-in. gage.

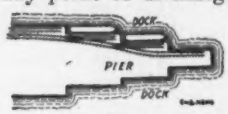


Fig. 7.

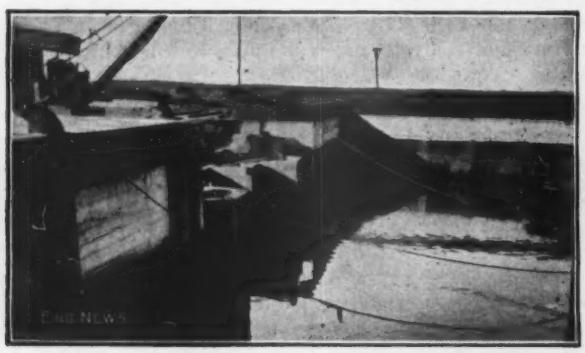


Fig. 8. Bahia Blanca Dock Walls Founded on Concrete Cylinders, Port Galvan

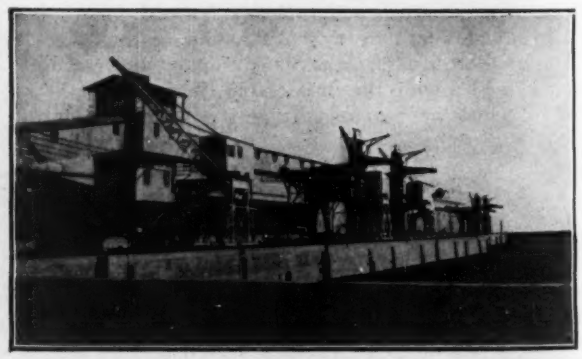


Fig. 9. Bahia Blanca. General View of Dock, Conveyor and Cranes

The new piers of both the Pacific and Puerto Belgrano Railways are built in the form shown in the accompanying sketch (Fig. 7), each of the steps being slightly shorter than the length of the ordinary vessels using them, and set back the full width of the vessels so that they overlap.

LA PLATA is the capital of the province of Buenos Aires and is situated on the "River Plate" about 30 miles south of the Federal capital. The docks are of masonry, the site having been excavated in low lying ground on a line perpendicular to the bank of the river. The port was built about 1890 with the idea that being nearer the deep water (Fig. 2), it would offer serious competition to the port of Buenos Aires, and help the development of the Provincial Capital, the approach channel being then dredged to 26 ft., 6 ft. deeper than the channel at Buenos Aires at that time. As, however, the channel at Punto Indio is the controlling feature and the port of Buenos Aires has always kept its entrance channel at practically the same depth as that at Punto Indio, La Plata never profited by the greater depth. It seemed to be successful at first but since about 1896 the trade has slowly declined and it has never been able to obtain more than a very small proportion of the imports and these of the least valuable class. All kerosene, gasoline, etc., is discharged and stored here as it is not permitted at Buenos Aires. The port is served by a mixed gage (5-ft. 6-in. and meter) line operated by the Government and having direct connections with the Southern Railway and two provincial narrow-gage lines.

SANTA FÉ—This city of almost 30,000 inhabitants, is the capital of the province of the same name. The port is at the head of ocean navigation on the Parana River, and for various reasons it seems likely that it will remain so, although it is thought that there may be eventually a deep-water channel opened up as far as the confluence of the Paraguay River and Alto Parana at Resistencia and Corrientes.

The present port, which has been built by the province of Santa Fé with substantial aid from the Federal Government, consists of a single dock about 2000 ft. long and 400 ft. wide, with masonry walls on pile foundation, which was only completed and put into service about two years ago. It is served by a mixed gage (5-ft. 6-in. and meter) railway operated by the National Government and which connects directly with the lines of the Central Argentine, Santa Fé and Government (Central Norte) Railways.

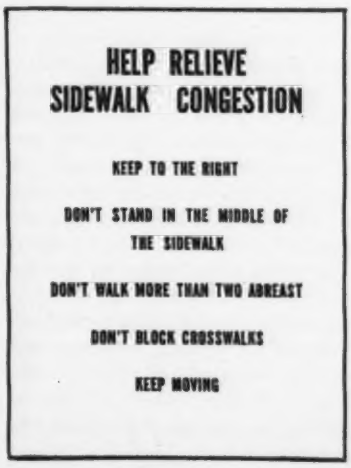
Another dock somewhat larger is being built alongside and there will be eventually additional quay frontage about 1 mile in length along the river. The port has 20 ft. depth of water and can be reached now at all stages of the river by boats drawing 16 to 17 ft. During high-river stages, which generally come at the time of the heaviest shipments of cereals, vessels drawing up to 25 ft. can make use of this port, the trade of which is practically all export, of cereals and quebracho, nearly all of the latter that is exported being shipped from Santa Fé. In the total distance of about 500 km. from the mouth of the river to Santa Fé, there is only a length of 20 km. requiring dredging, to maintain a depth of 25 to 30 ft. of water at all stages, and the channel at these bars may eventually be kept open by properly constructed training walls or other works.

RAILWAY GAGES

It may be noted that the port situation is everywhere somewhat complicated by the question of the gage of the railways. The lines on what may be called the main land of the Argentine are all, with one small exception, 5-ft. 6-in. and meter gage. The Mesopotamian provinces of Entre Rios and Corrientes, and to the north of them Paraguay, are served by lines of 4-ft. 8½-in. gage and these are now becoming an important factor in the railroad situation, as they have been brought across the River Parana and so into Buenos Aires by a car ferry which traverses one of the longest ferry routes in the world, some 40 miles in length. The ports of Buenos Aires and Bahia Blanca are served by broad-gage lines only, while those at La Plata, Rosario and Santa Fé have the two gages. With the advent of the standard gage at Buenos Aires, there are now lines of all three gages reaching the city and involving the transfer from two of them to the broad-gage tracks of the Port Railway with all its consequent expense and delay which, of course, is greatly increasing as the country served by the 4-ft. 8½-in. gage lines is developing very rapidly.

The writer wishes to acknowledge his indebtedness for much of the information contained in this article to a report on the harbor works made to the Argentine Railway Co., by Ian Barry, M. I. C. E.

To Help Relieve Sidewalk Congestion in Boston enameled signs are freely placed on poles and posts standing in the sidewalks. These signs are about 6x8 in. in size, with black letters on a white ground, as shown by the accompanying figure.



A Valuable Safety Warning for Street-cars—The warning sign idea represented in the preceding is used in an ingenious way in many European street-cars. Near each exit door is a small enameled sign instructing passengers how to dismount safely. The sketch reproduced herewith was made from the signs used in the Zürich (Switzerland) cars. Often two signs are used at each door: One on the door itself, the other on the jamb, where the passenger ready to step out cannot fail to see it.

Two Rapid-Transit Subway Projects for Milan, Italy, have been recently proposed by the municipal authorities. One is a short subway to carry the street railways of the city as single cars through the congested business district; the other is a two-track subway extending from the center of the city well out into the residence section and is to be used for multiple train operation. Neither, apparently, is likely to be built in the immediate future. The information is interesting, however, as an indication of the tendency toward modernization of some of the Old World cities.

Shop Methods Which Expedite Field Erection

By Edward J. Knapp*

SYNOPSIS—Expensive fieldwork can be saved by doing all possible assembling in the shop, and avoiding arrangements which call for awkward or slow operations during erection. The author's suggestions are based in part on practice in erecting car-dumpers and like structures.

Going back over my own experience I recall few firms who do not complain that field erection costs too much money. Possibly it is a habit with them to complain just on general principles, thinking it will act as an inducement to the erector to make an effort toward lowering the cost. But, instead of having the desired effect, the erector becomes inured to it and lets it go in one ear and out of the other. Better results will be obtained by studying the conditions and applying a suitable remedy.

Many erectors are hampered by lack of equipment. Plenty of tools of the right kind, depending on the nature of the structure, are essential. I recall an instance where an erector was employed to erect a rolling-trunnion bascule lift bridge of about 150-ft. span, which had to be erected in the open position. This required a special type derrick. The contractors for the structure were strangers to this kind of work, never having done any structural work before, and they had no tools. Their lack of experience is shown by the fact that they bid $2000 for the erection.

Naturally when a practical erector was hired he wanted tools. He started in to build a derrick which very soon demonstrated that the job was going to cost way over the amount bid. Here friction between the erector and his employers started. They told him that he did not know his business, and that a good man did not need tools. The result was that the erector quit. The contractors later became satisfied that tools were necessary and finally succeeded in erecting the bridge at a great loss.

This goes to show that the tools do not get enough attention, but this is not the only drawback to economical erection. The shop can help materially in lowering the cost of erection, in other matters than tools.

The usual method followed by the shop is to get the work out as cheaply as possible, paying particular attention to their own costs, but disregarding the field costs entirely. As long as the work checks to the drawing, it is sufficient. There are many places where work can be done in the shop in preference to doing it in the field. Possibly the drawing does not call for it, but as the total cost comes out of the same pocket, and the work can be done at less cost in the shop on account of the crane service, power and tools, there is no reason why it should not be done there. The reason why it is not done is on account of lack of forethought, a desire to make a record for low shop costs, or a lack of field erection knowledge.

Work is more expensive if done in the field on account of the higher rate of pay. The average rate there is between 60 and 65c. per hr., while in the shop the maximum average will be 24c. Then there is the accessibility; working scaffolds must be built and separate rigging run to put in a piece that might just as well have been assembled in the shop.

There is no doubt that the drawing room is aware of the fact that there should be as many shop rivets as possible, and is doing all it can in the design to eliminate field riveting. Practically, we know that at some place a line must be drawn, controlled to a great extent by erection equipment. But concerning shop assemblies, the field for saving erection labor is large.

Considering sheaves and their support: It is hard to tell just how much work the assembling outside of the shop would mean, but in almost any circumstance it would be cheaper to do it in the shop, where the work is on the floor and cranes are available to do the lifting. In most cases in the field, it would mean separate rigging to lift the sheaves into place and the building of scaffolds for the men to work on while the pin is being put in. I have known cases where the erector has put the sheaves in place on the ground before hoisting the support into place. This in itself is proof that the work might just as well have been done in the shop. The only argument against such assembling is railroad clearances and rates. It is seldom that height or width would interfere with the shipping of pieces by water.

The railroad freight rates are interesting in this way: If the sheaves or machinery are assembled with the structural work, the whole shipment might be forced into the machinery class, which takes a higher freight rate than structural material. But the shipping clerk can control this to a large extent. He can size up the job as a whole and work structural supports with the sheaves in place in with other machinery so that the weight of the structural material is at a minimum. In this way it will go through without being noticeable. It is doubtful if the additional cost of shipping on account of structural material being classified as machinery would equal the saving in field labor by having the assembling in the shop. Even though a car is loaded just the opposite, a minimum amount of machinery with a maximum amount of structural, it is doubtful if the railroad inspector would class the load as machinery.

It is not only in the assembling of sheaves that time can be saved. All through a machine there are numerous castings that can be put on in the shop. It simply needs a little forethought along the right lines. A consideration of alignment is essential, however. It would not do to ream and bolt bearing pedestals for line shafts permanently in the shop, that is if the pedestals are on different structural members, because it would be an exceptional case if the erector would be able to get the structural members in place so that the bearings would line up. In case the bearings are adjustable, or on sole plates, the erector would have no trouble in getting the alignment, therefore, it would be advisable to do the work in the shop.

Ore-handling bridges have the moving mechanism extending across the bridge and down the legs as a rule. Here the bearings cannot be put on in the shop unless the

*455 E. 118th St., Cleveland, Ohio.

legs are assembled complete, but there is still a chance to help the field. The holes for these bearings could be punched, say about ⅛ in. smaller than the permanent bolts, giving a chance to bolt the casting in place temporarily, adjusting it and reaming the holes to size. I have noticed cases where these holes were omitted entirely.

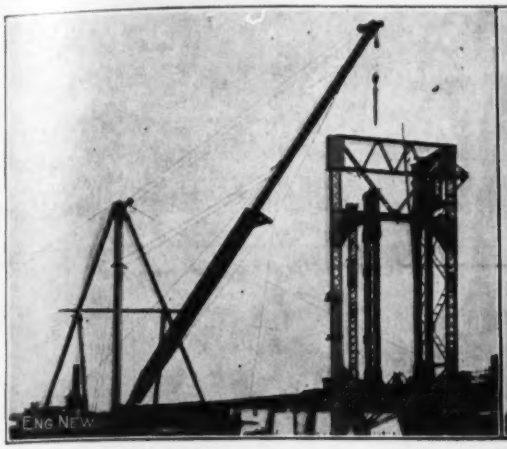


FIG. 1. PLACING THE FIRST COLUMNS FOR A STATIONARY CAR-DUMPING MACHINE

(The derrick is so placed that the whole structure can be erected without changing the setting.)

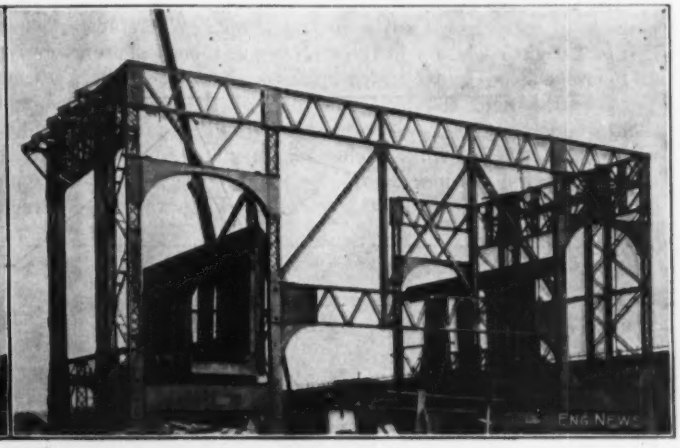


FIG. 2. PUTTING IN CRADLES BEFORE SIDE NEXT DERRICK IS COMPLETED

Where the casting fastens to a member in the vertical position, it means a great deal of work and extra time to get the casting in place and hold it. It means the placing of the casting, clamping it in place, adjusting, marking off the holes on the structural work, removing the casting, drilling the holes, and replacing the casting, and then in some cases it also means reaming, as it is sometimes thought advisable to drill the holes small so that through reaming a good true hole is obtained. To do away with this excess work, the drawing room should furnish the shop with the layout of all holes that take mechanical parts, noting that they should be punched small and reamed to size with castings in place.

In some cases there is so much machinery connecting to structural work, such as engine beds or hoist beds, that

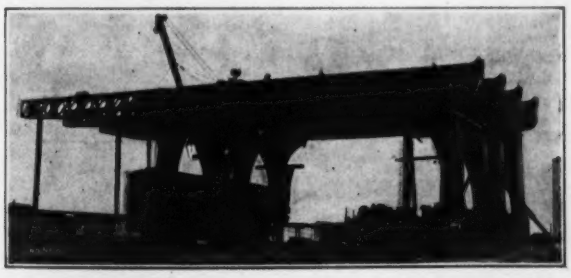


FIG. 3. MAIN FRAME OF WELLMAN-SEAVER-MORGAN CO. 8-TON COAL UNLOADER, SHOWING LONG MAIN GIRDERS

it pays to assemble the structural members and put the castings on. This serves two purposes; it checks the work and saves drilling for the casting bolts in the field. When this is done, the structural members must be match-marked and the castings match-marked with the structural work, so that the field will have no trouble in putting the work together again in the same way it was in the shop. I have witnessed the above in numerous cases and have found no trouble in getting good true holes for the bolts.

Marking both iron and machinery, giving symbols, pattern number and drawing number is an important point, but it is often neglected, forcing the erector to check up the work to see what each piece is and where it goes. It is a large amount of work for a field man to go over twenty or thirty tons of material and have to check members here and there to find what he wants next.

This does not necessarily entail extra work on the shop. The fitter can be instructed to mark each shipping piece as he assembles it. One shop which I call to mind goes so far as to brush linseed oil over the marks. This is a good idea, as it preserves the mark and keeps it from becoming dirty and illegible. The linseed oil forms a transparent film that it easily seen through.

There is a large field for saving time of the field force through careful marking. It is practical for the shop to go so far as to designate the top side or end, and the near side of a member, or in other words the position the member is to take in the finished structure. Many erectors detail a man to look over members and mark them, so that the erecting gang simply has to hook on to them and hoist them into place. It saves a great deal of time for men who are at work out doors with the wind blowing, or in storm or in severe cold, not to have to bother with detail drawings. The erection diagram is all that is necessary as this gives them the symbol and drawing number. It would be a very simple thing for the shop inspector to mark with paint the top end and near side of braces and diagonals; or for chords, the end toward the pier. Taking smaller jobs where the erector does his own "picking out iron," as well as the bossing, to have the iron so marked would stop delays on the part of the gang while the boss is checking a member to see what position it takes.

The drawing room could be a help in this matter by putting notes on the drawings, designating the position the material occupies in the structure. This would save the shop the trouble of referring to the erection diagram.

Match-marking is also important. It may be said, "What is the use of putting work together in the shop if it is not match-marked so that the erector can reconstruct it in the same manner?" Nevertheless, I have known cases where the work was not match-marked after a shop assembly.

In erecting two or more ore bridges for instance, each having two lines of top and bottom chords, it would be possible to interchange any similar sections. Therefore, if it is thought necessary in the shop to put them together to insure a good joint, match-marking should be done. Further, the field should be notified of the fact and should understand the system used. I recall an instance where there were six lines of chords. In match-marking, the shop failed to designate to which line each member belonged. As a result the match-marking was useless. Each line should have been identified with letters and the joints with numbers. Thus the joints of the first line of chords should have been marked A-1, A-2, A-3 and, the second line of chords B-1, B-2, B-3, etc.

With reference to shop inspection, most members slip into place by their own weight, therefore the built-up sections must not be allowed to over-run or under-run as the case may be. A sixteenth or an eighth of an inch is not too much to allow for a good free connection; for if a member does not slip in free and has to be forced, there is sure to be extra time consumed. One or two men will have to go to the ground for chains and a steamboat ratchet and force the member into place. Erection has been held up as long as a half a day just because one connection gave trouble.

Rivets shop-driven in field connections often cause a serious delay. They are seldom noticed until the next member is up and ready to connect, necessitating a hold-up of the work until the rivets are cut out. An erector was heard to say that it costs a dollar a rivet to cut them out. Although this assertion sounds exaggerated, it is possible to believe it when the amount of work, rate of pay, and number of men kept idle are taken into consideration.

The shop inspector should see that all loose pieces, such as splice plates, fillers, etc., are bolted in place where they are to be used. This avoids the risk of their being lost and saves time by not having to hunt elsewhere for them.

Time can often be saved by shipping long cumbersome material the right end to. That is, so that when the cars arrive at the erection site, material will not have to be turned end for end. Consider the main girders used on a modern ore unloader. These girders are 4 ft. 6 in. wide, 7 ft. 7 in. high, 90 ft. long, and weigh about 130,000 lb. It is easy to see the amount of work entailed by having to turn these long heavy girders end for end. Offhand a person would think it impossible to load the girders in the shop so that they would arrive at destination the proper end to; but it has been proven that it can be done.

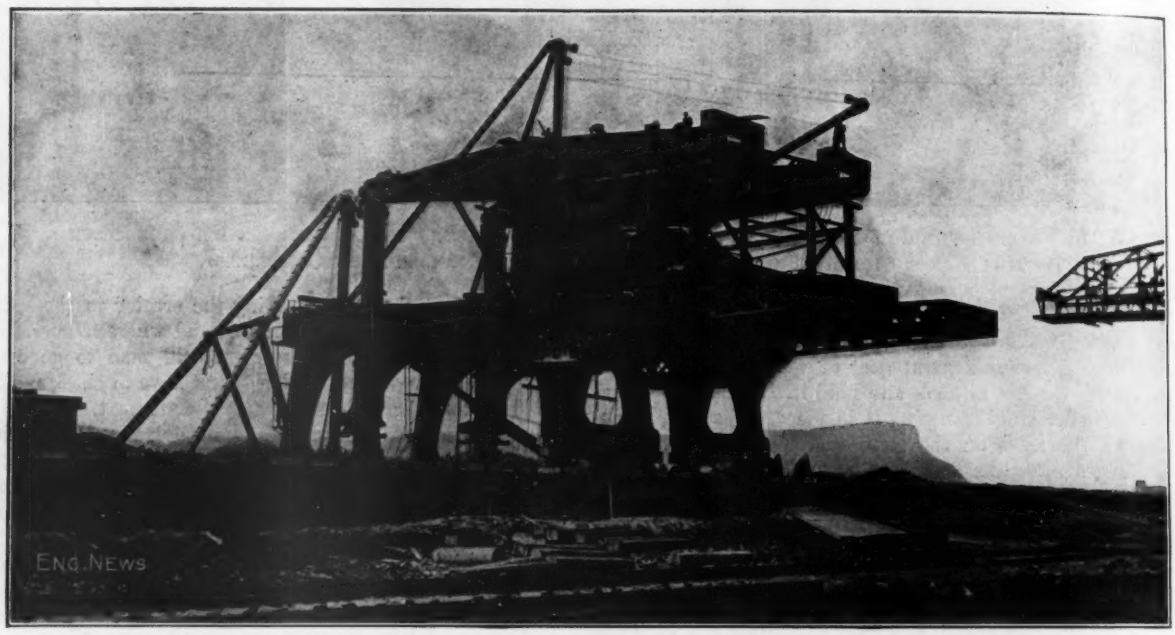


FIG. 4. COAL UNLOADERS WITH TROLLEY WALKING-BEAM AND BUCKET LEG IN PLACE
(These are assembled complete in the shop and match-marked.)

When shipment of a job is begun there are always erecting outfits or small material that can be loaded and shipped first. Mark these cars as loaded in the shop, by noting one end of the car as being toward the north, south, east or west, as the case may be. Notify the erector of the condition, and then when the cars arrive he will be able to let the shop know which way to load the long material. Where the shop is not equipped to turn such material, a "Y" can be found along the route, and the railroad given instructions to put the cars over the "Y." This method has been followed successfully in the case of these long girders and other material.

To bring the field handling to a minimum, the material should be shipped in the order the erector needs it. This can be accomplished inexpensively by storing the material as it is fabricated, in such a way that the members wanted first can be gotten at and shipped. By referring to the erection diagrams, it is easy to foretell what the erector will want first.

One of the pictures herewith gives a good idea of how a car dumper is erected. The derrick is placed in a convenient place, where all parts of the structure can be reached with the boom. The columns are put up first, followed with bracing, etc. The cradles are erected before the main frame is completed, so that the manipulating of the derrick is unobstructed.

The drawing room and order department can be a big help to the shop in sorting the material by billing the job subdivided into units. The shipping department will then be able to take the bills and ship just what the erector wants first, without chance of overlooking important members, which if not shipped would hold up the erection.

The drawing room can save a great deal of time that steps that will stop as much spoiling as possible. Then the purchaser cannot come back and say that the material was not properly shipped.

When field rivets are put up for shipment, the different sizes should be sorted into kegs or boxes and each package plainly marked as to contents. This will save a great deal of scattering, due to the men breaking open the packages in search of the size wanted. As a rule, on erection work there is plenty of rubbish and loose sand or dirt around in which loose rivets can be buried and lost, thereby causing shortages that eventually mean replacement.

The shop inspector, in coöperation with the shipping clerk, can by foresight and proper planning do a great deal to make possible economical erection. But they

FIG. 5. COAL UNLOADERS PRACTICALLY COMPLETED

is now spent in the field drilling holes for fastening electric wires and conduit. There is no reason why the method of wiring a machine cannot be predetermined to the extent that the connection holes could be laid out and punched with the fabrication holes.

In my experience I have seen both methods followed, and have found that if care is taken in predetermining the layout a great deal of field labor is saved. Field drilling is as expensive as cutting out rivets.

All loose bolts should be well slushed, especially the threads. Too often they are shipped just as they come from stock. Being shipped in open cars, although boxed, rain and moisture is bound to get at them, sometimes rusting them to such an extent that they cannot be used. I have known instances where it was necessary to keep a man running the nuts down on bolts to get them in a fit condition for erection purposes. In one instance the bolts were so badly rusted that it was necessary to replace them. Here the boxes containing the bolts had been allowed to lay out in the weather until needed. Of course, this is wrong, but as the shop cannot foresee to what treatment the material will be put, it is well to take must be given the opportunity to study erection conditions, especially the inspector.

A trip to an erection site by the inspector once in a while will well repay the company in the fund of information brought back. Talks with the erectors as they come in from jobs, going over the drawings with them to find out the places that brought trouble, will suggest many changes for saving time, labor and expense on succeeding work.

Waste Paper from the Refuse Collections at Denver, Colo., is being baled at the municipal coal yards under the direction of the Board of Charities and Corrections (Dr. J. M. Perkins, Commissioner of Social Welfare). The following note on the subject is taken from "The City of Denver," a semi-monthly publication, published by the city and supplied "free on request to taxpayers":

Employment has been given to a great many transient men and some women in the new industry of baling the waste paper of the city, three carloads of which have been recently sold at a fair price. Paper is collected from the large stores and from receiving cans on the street corners, is sorted, baled and shipped to market at about the rate of a carload a month. While not a big financial benefit to the city, this method of handling the paper serves the double purpose of getting rid of the waste paper without cost and at the same time furnishing work to jobless men. The revenue from this paper industry now supports the families of the men employed at it, and in addition adds a little to the general funds of the department.

Cause of Dry Rot in Factory Timbers and Its Rapid Increase*

Dry rot in hard-pine timber structures (caused by a fungus growth in the cells of the wood) is rapidly increasing and this condition is chiefly due to the use of less resistant timber. These are the conclusions reached by F. G. Hoxie, Engineer and Special Inspector, of the Associated Factory Mutual Fire Insurance Companies, of 31 Milk St., Boston, Mass., after a study of nearly 20 cases of dry rot, involving the examination of several thousand wooden beams in infected mills. A 34-page booklet by Mr. Hoxie describing this investigation has just been printed by the Factory Mutual Companies and can be obtained by engineers interested.

The percentages of rosin at points A, B and C, in each beam, are given in the following table:

A	B	C	A	B	C
5.36	7.04	0.68	29.21	12.17	0.88
4.46	1.99	0.76	6.26	6.56	0.58
8.36	4.89	1.17	3.45	18.81	0.99
7.72	5.12	0.83	9.45	2.31	0.82

EXAMPLES OF DRY ROT IN TIMBER, SHOWING VARYING PERCENTAGES OF ROSIN

Only four varieties of American hard pine are used to any extent for timber in the Eastern States. The American Society for Testing Materials recognizes only two classifications of hard pine, calling good material long-leaf pine and poor material short-leaf pine. In structural timber the qualities of first importance are strength and durability. The breaking strength of timber can easily be specified, but can be tested only by the destruction of the material. The density is probably a sufficiently close index of strength, for commercial purposes; and the percentage of rosin determines the durability with reasonable accuracy.

The presence of sufficient rosin in the wood is of prime importance as it prevents decay. The amount of rosin in timber just sufficient to stop the fungus is about 3%. A mill beam, if not artificially treated, should contain at least 5% of rosin uniformly distributed throughout, to be safe against the ravages of dry rot.

The relation of the rosin percentages to the durability is indicated in the accompanying cut which shows eight rotted, 12x16-in. pine beams removed after two years.

A source of infection of lumber is the sticks used for separating the lumber, and the rotten wood stringers on which it is often piled in the lumber yard. If the lumber is susceptible, it is almost sure to become infected with the fungus under such conditions. To combat this it is suggested that the lumber in storage yards be piled upon concrete supports.

Mr. Hoxie makes the following summary of his observations:

(1) The percentage of rosin in hard pine can be taken as an index of its power of resistance to dry rot. (2) Hard pine lumber, 12x12 in., or larger is practically not obtainable with sufficient natural resistance to withstand fungus, in a moist atmosphere. (3) The nonresinous and sappy hard pine, which is obtainable, is not safe to use for the important parts of a building, without antiseptic treatment. (4) Holes through columns, or narrow spaces between beams and hollow spaces in floors or roofs, are of no value in preventing dry rot, and serve to rapidly spread it to all susceptible material. (5) Heating a new building to about 115° F. for 24 hours, several times, has a value well worth its cost in preventing serious dry-rot damage. (6) Of the various antiseptic treatments in practical use at present, corrosive sublimate appears to be the best adapted to mill timber. Modification of the present process may be necessary when deeper penetration is required.

Most of the timber framing of mills recently erected is of North Carolina, Cuban or shortleaf pine; and nearly all of the affected lumber examined was in comparatively new buildings. The best grades of these varieties are probably as resistant as the longleaf pine; but these varieties are less uniform and their inferior grades are more difficult to detect by the usual superficial inspection.

*Matter by C. H. Smith and F. J. Hoxie on this same subject was published in "Engineering News" of Dec. 21, 1911, on p. 727 and discussed editorially on p. 743.—Ed.

An Antipodean Engineering Fee—The fee to be paid Sir Maurice Fitzmaurice, chairman of the British Admiralty, and a member of the firm of Coode, Mathews, Fitzmaurice & Wilson, engineers, who is to report on the construction of naval docks and harbor works for the Commonwealth Government, is £4700. The amount is based on a stay of six weeks, and is to include consultation with Sir Wm. Mathews, who reported on the proposed improvements of the Melbourne Harbor Trust in 1910, on returning home, firm's staff charges and all expenses; everything, in fact, except Australian assistant from Government staff for survey and collection of local engineering data.—"The Commonwealth Engineer," Melbourne, Australia.

A Standard Scale of Engineering Charges was adopted by the Institute of Engineers, of Victoria, Australia, at its meeting in November, superseding a previous schedule adopted in 1905. The new scale of fees provides for both percentages and per diem rates of payment. The latter varies from a minimum of four guineas ($20) per day for consultations, calculations, reports, etc., made in the engineer's own office, up to ten guineas ($50) per day. The percentage charge is 5% of the entire cost of engineering works ranging from $10,000 to $1,000,000 in value. One-fifth of this percentage is payable on the completion of the preliminary design, two-fifths when the plans and working drawings are completed, and the balance on the completion of the work.

Construction Details of Lock and Dam No. 19, Ohio River

Dam No. 19 across the Ohio River at Little Hocking, Ohio, about five miles below Parkersburg, W. Va., is one of the thirteen dams now under construction by the United States Government as a part of the 54 dams which will finally cross that river in the development of the 9-ft. slack-water navigation authorized under the River and Harbor Act of 1910. Dam No. 19 is quite similar in design to the other Ohio River dams; that is, it comprises a lock, a navigable pass closed in ordinary water by Chanoine wickets and a bear-trap dam. On account of the sudden rises in the Ohio River with the consequent flooding of all construction work and also because of the difficulties in building coffer-dams along that river,* a description of the successful construction of Dam No. 19 should be interesting. Work was started in 1911 and has progressed during the past three seasons.

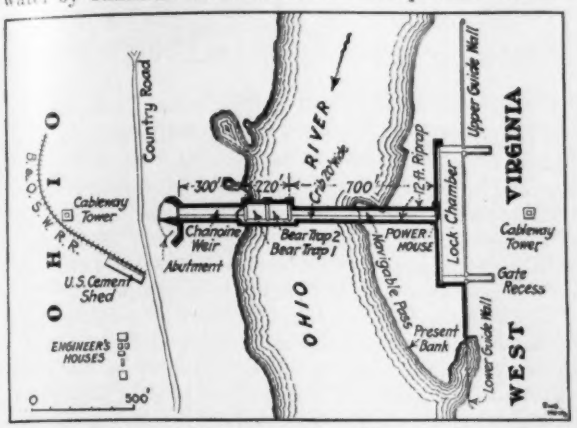


FIG. 1. PLAN OF LOCK AND DAM NO. 19, OHIO RIVER

The dam and lock, as shown in Fig. 1, comprise a lock chamber on the West Virginia side of the river, 700 ft. long by 110 ft. wide, with guide walls about 600 ft. long on both the up and downstream ends of the lock; a length of 700 ft. of navigable pass, which consists of the usual Chanoine wickets founded on flat concrete slabs; two bear-trap dam sections 220 ft. long, and at the most northerly end of the dam, a Chanoine weir section 300 ft. long abutting against a wing abutment reaching into the slope of the valley. The drawing shows the low water banks of the river. The Chanoine wickets will be raised to hold back the water to allow a 12-ft. depth over the lock sills in low water, and in high water will be lowered to permit the passage of boats through the main channel of the river. The contract, in addition to the construction of this part shown, includes as supplemental work the grading and paving of the esplanade south of the lock.

The river at this point is about 900 ft. wide and varies in depth from a few feet at low water to 59 ft. in time of flood. The Ohio Valley is some 200 ft. wider than the river here, and very flat and low compared to the hilly country through which it runs. During high water the entire valley is submerged. Floods occurred at irregular intervals during the progress of the work and added greatly to the difficulty of continuing construction. All of the works in construction of the dam and lock have been submerged several times since the commencement of operation in 1911. The Spring floods of last March and April were particularly severe. It was impossible at that time to withdraw the working plant to points of safety or to strengthen the temporary work sufficiently to stand the strain of the high water. An additional difficulty lies in the fact that the heavily laden water has left at every flood a considerable thickness of sediment inside the coffer-dams and on the construction already up, which entailed a large amount of reëxcavation.

The work was divided into two distinct parts, the lock being completed as a separate construction in an independent coffer-dam, and the remainder of the dam in a series of short coffer-dams.

The lock, as shown on Fig. 1, is 110 ft. and 700 ft. long. The river wall is a monolithic concrete prism in section and is founded on bedrock. The shore wall is a gravity-section concrete retaining wall founded on piles reaching down to the rock. The lock was constructed by inclosing it on the three water sides with a coffer-dam 900 ft. long by 300 ft. wide and 16 ft. thick. A typical section of this coffer-dam is shown to the left in Fig. 2.

In constructing the dam, guide piles about 25 ft. long were driven 5 ft. into the gravel bottom and spaced about 16 ft. c. to c. in line with the coffer-dam, and about 18 ft. c. to c., transversely. On these guide piles four lines of 6x8-in. waling pieces were spiked and vertical 2-in. sheathing was then fastened to the waling pieces and driven a slight distance into the ground. The box was tied with cross-rods through the waling pieces and filled with earth fill, this puddle forming a core-wall coffer-dam about 20 ft. high. On either side of the dam, earth was backfilled on a 1 on 2 slope. Openings were left in one or two places and flood gates put in to allow the coffer-dam to be flooded during high water.

The river side and upstream arm of this coffer-dam were constructed first and three derrick boats, fitted with 1-yd. clam-shell buckets, were brought inside to excavate the material for the core-wall of the dam and for the side slope. When this much of the wall was finished, the boats were floated out through the lower end and the lower arm put in place, thus completing the coffer-dam. The whole area was then unwatered with four 10-in. centrifugal pumps. Excavation was continued by clam-shell buckets on two derricks which traveled on a 16-ft. gage track, located inside the coffer-dam.

A trench was excavated for the land wall of the lock to an excavation 8 ft. below low-water level, about 600 ft. long and 20 ft. wide at the bottom. Water was drained off the site by means of pumps placed in ditches along the trench. In this trench, five rows of 12-in. piles, 20 ft. long, spaced about 3 ft. c. to c., were driven through gravel to the rock and cut off at an elevation about 2 ft. above the trench bottom, or 1 ft. below the finished floor of the lock chamber (Fig. 2), p. 240. In order to prevent the river from undermining the wall, finished permanent sheet piling was driven to the rock about 1 ft. in front of the face of the wall. These piles were cut off and fastened at the top with 6x8-in. waling pieces, which in turn were bolted to the top of the pile supporting the wall. The surface of the ground was level preparatory to receiving concrete and the wall, a stepped section, as shown in Fig. 2, 28 ft. high, 16 ft. wide at the bottom, narrowing to a width of 5 ft. at the top, was concreted in alternate monoliths 40 ft. long and 14 ft. high.

*See description of failure of two Ohio River dams: Dam No. 26, "Eng. News," Aug. 22, 1912, p. 316, Dam No. 48, "Eng. News," July 31, 1913, p. 231.

The land wall being completed, excavation was started from the upper and lower gate recesses and the upper half of the river wall, the excavated material being placed in back of the land wall for backfill. Piles 12 in. in diameter and 10-in. permanent sheathing were driven, as described before, and the walls concreted in alternate monoliths about the same size. The foundations of the river wall were carried all the way to rock, as shown in Fig. 2. To accomplish this, steel sheet piles 20 ft. long were driven to rock on either side and the material was excavated and placed in back of the land wall as backfill. The rock surface was prepared to receive concrete by blasting a 2-ft. groove in the rock along the center of the wall. The river wall was then concreted as monoliths, as described before, and backfilled. The braces for the steel sheeting were removed and the piles pulled out.

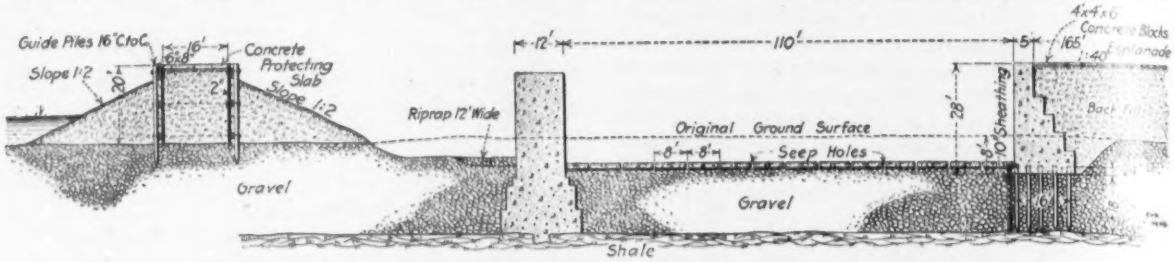


FIG. 2. SECTION THROUGH COFFER-DAM AROUND LOCK NO. 19, OHIO RIVER

After all the lock walls were completed the floor of the lock chamber, shown in Fig. 2, was laid. This floor had to be provided with seep holes to allow the water to rise in the chamber at flood times and relieve the pressure on the bottom of the lock. This was provided for in the following manner: Where earth was encountered in the lock chamber it was excavated a few feet below the required grade and backfilled with gravel and leveled off. Wooden blocks, 6x6x24 in. with tapering ends (Fig. 3) were driven 6 in. into the ground every 8 ft. across the chamber floor and every 6 ft. along the length through the lock. These blocks were provided with a groove 3/8 in. wide in the middle of each side, 1 in. deep throughout the length. They also had a ring bolt to allow their being pulled out after the concrete had set. Steel plates 18 in. high and 1/4 in. thick were placed in the groove, thus forming boxes 8 ft. long, 6 ft. wide and 18 in. deep. The plates were also furnished with two rings at the top in order to allow their being withdrawn after concreting. In the center of each of these boxes was placed a round, wooden stick 3 in. in diameter with the end tapered and provided with a ring at the top for pulling.

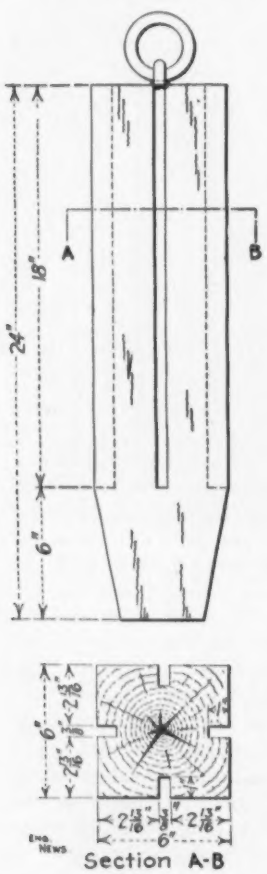


FIG. 3. BLOCKS FOR CORNER FORMS OF LOCK FLOOR

These boxes constituted the forms for the lock chamber floor. After the forms were filled with concrete and had set for a few hours, the 6x6-in. corner blocks and the round 3-in. center sticks were pulled out. A few hours later the steel plates were also pulled, leaving a system of concrete blocks 8 ft. long, 6 ft. wide and 18 in. high, with a 1/4-in. slot between and a 6x6-in. hole at each corner, as well as a 3-in. round hole in the center.

The upper and lower guide walls were built behind coffer-dams of the same design and cross-section as the main coffer-dams. These guide walls were built in the same manner as the land wall and the lock proper; that is, on piles driven to rock and protected by permanent sheathing. The walls were practically a continuation of the land wall and extend for a distance of 600 ft. in either direction. In cross-section they are 9 1/2 ft. wide at the bottom, stepping up to a width of 5 ft. at the top and are 21 ft. high.

The land wall has two indents for the gate recesses in which the sliding lock gates are rolled when the lock is open. Between these recesses an esplanade runs from the land wall 150 ft. back to the sodded terraces. This esplanade is paved with 4x4-ft.x6-in. concrete blocks, as shown in Fig. 2.

The second part of the construction comprises the navigable pass, the bear-trap dam and the Chanoine wickets. The navigable pass consists of a concrete slab 35 ft. wide and 5 ft. thick, resting on 12-in. wooden piles driven to rock a distance of about 20 ft. and protected from undermining by permanent 10-in. triple-lap sheet piling, extending from the upstream face down to the rock and bolted securely into the concrete slab. The elevation at the top of this slab is about 6 ft. below low water. The upstream face is also protected by heavy riprap for a distance of 12 ft. and the whole dam is reinforced on the downstream face by a crib sunk with heavy stone to within 10 ft. of rock bottom, and riprap is placed behind this crib for a width of 12 ft. The crib itself is further protected by 12-in. sheathing on the upstream face.

The two bear-trap weirs extend for 220 ft. near the middle of the river between the navigable pass and the Chanoine weirs. The foundations for these bear-trap weirs rest upon solid rock 7 ft. below low water. There are three piers, one at each end and one at the center, 85 ft. long, 12 ft. wide and 25 ft. high, the long axis running parallel with the river. The foundations for these three piers rest upon solid rock at about the same elevation as under the navigable pass.

The foundations for the Chanoine weir section at the Ohio shore consist of a concrete slab about 40 ft. wide

resting upon and bonding into solid rock about 1 ft. below low water. Considerable rock excavation was required for these foundations. On the Ohio side of the dam is erected an abutment with wing walls, etc., the foundations for which rest upon rock.

In order to construct these dams across the river and not interfere with the flow of the river, each class of dam in turn was inclosed in a coffer-dam of the same general design as described before. The navigable pass was first completed and the coffer-dam inclosing it removed and the river allowed to flow over this completed section while the coffer-dam for the bear-trap weir was constructed. The bear-trap weir was then completed and its coffer-dam removed before the Chanoine weirs were started.

Plant

The plant needed to execute this work consisted of a central boiler plant of nine boilers of the locomotive type, totaling about 1000 hp., which furnish power to run all derricks and machinery; one steel guy derrick with a 75-ft. mast and 70-ft. boom on the shore to handle concrete and forms for the lock and guide walls; one wooden-guy derrick, fitted with a 1-yd. clam-shell bucket, on the land wall to handle excavation; three stiff-leg derricks with 60-ft. booms inside of the lock chamber to handle excavation, concrete and steel sheathing; and one stiff-leg derrick at the stationary concrete mixer to handle material from the scows to the mixer bins. There are also three derrick boats in the river, fitted with 1-yd. clam-shell buckets for dredging material from the site, and one ladder dredge and washer which excavated and washed the gravel ready to put in the storage bins.

The 16-ft. gage traveling derricks, with 50-ft. booms, were located in the lock chamber for handling material, and on the West Virginia bank, alongside the lock, was situated a stationary 1-cu.yd. batch concrete mixer with a 75-ft. concrete tower with chutes for concreting lock and guide walls. In the river there was a 20x80-ft. scow fitted with 1-cu.yd. batch mixer and storage bins for sand and gravel and a cement shed. There were also five small scows to carry sand and gravel from the excavation to the storage bins and one Ohio River stern wheel tow-boat to transport the fleet.

An inclined railway was built to haul coal and cement from the railway siding on the government land to the storage shed on the site. A cableway with a span of 2200 ft. and towers 140 ft. high was installed to carry operating machinery across the river at high water and also to carry the machinery from the river to places of safety during the floods.

Personnel

The work is under the supervision of Capt. F. W. Altstaetter, Corps of Engineers, U. S. A., and the contract is being carried out by The Foundation Co., 115 Broadway, New York City, under the direction of E. S. Jarrett, Vice-President of the company.

A Very Large Steel Gear Wheel with Triple Staggered Teeth was recently made by the Mesta Machine Co., of Pittsburgh, Penn., for the Inland Steel Co., of Chicago, Ill., and will be used for driving a sheet mill. This gear is 22 ft. 8 in. in diameter with a 38-in. face and a circular pitch of 5½ in. The mating pinion is 2 ft. 11 in. in diameter. The gear has 154 teeth and the pinion 20 teeth. In addition to its very large size, the design of the gear differs from common practice in the fact that the teeth are staggered in three parallel sections. The gear is built up of six parts; the gear center carries the central rim segments of teeth.

Relation of Purity of Water-Supply to Typhoid Fever at Cincinnati, Ohio*

By J. W. Ellms†

For the three years preceding the introduction of a purified water-supply, Cincinnati's typhoid death-rate averaged 53 per 100,000 population. For the five years following the purification of the water-supply the death rates per 100,000 were 19, 13, 5.7, 11.4, and 7.1, respectively. This represents an average reduction in the number of deaths from this disease of nearly 80%. The reduction in the cases reported is very nearly 85%, when estimated for this same period. Whether other sanitary reforms approximately coincident with the purification of the water-supply have not played some part in the diminution of cases from this disease, the writer is not prepared to say; but there is little doubt that the principal agency has been the substitution of a pure for an impure drinking water.

A careful study of the accompanying table with a view to establishing some relation between the fluctuations in the typhoid death-rate and the quality of the water does not lead to any very positive conclusions. It immediately raises a question as to whether we really obtain any direct measure of the purity of a water in the usual bacterial examinations which are made. So far as the total number of organisms removed is concerned these results indicate a water of high purity. On the other hand the presence of fecal or gas-producing organisms likely to be associated with the typhoid bacillus, as shown by the presumptive positive B. coli figures, would lead one to believe that the entire absence of these organisms in a water is by no means absolutely necessary as an indication of what experience has shown to be a safe drinking water. The reduction in the number of B. coli effected by filtration alone is evidently in the same proportion as that obtained in the reduction of the total number of bacteria. No selective action takes place in filtration, although there appears to be some such action when the disinfecting agent, calcium hypochlorite, is used.

So long as bacteriology is unable to furnish reliable and rapid methods for the isolation of pathogenic organisms in water, it will be necessary to rely on circumstantial evidence, such as has been furnished by the remarkable reduction of typhoid fever in Cincinnati, following the introduction of a purified drinking water. Since all those cases, in which the source of the infection remains untraced, may have been infected through agencies such as flies, shell-fish, raw vegetables, fruits and bacillus carriers, it reduces the probability of our present purified drinking water being a source of infection to practically zero.

COMPARISON OF THE TYPHOID FEVER DEATH-RATE WITH THE HYGIENIC QUALITY OF THE WATER-SUPPLY OF CINCINNATI, 1909 TO 1912

	1909	1910	1911	1912
Typhoid-fever death-rate per 100,000 of population	13	5.7	11.4	7.1
Percentage reduction from average death-rate for three years preceding introduction of filtered water-supply	75	90	79	89
Average number of bacteria per c.c.:				
In river water	9,300	8,900	13,790	11,130
In filtered water	75	75	39	26
Percentage reduction of bacteria by purification	99.2	99.2	99.7	99.8
Yearly percentages of presumptive positive B. Coli results obtained in various amounts of the river and filtered water:				
In river water in 1 c.c.	93.2	91.0	85.3	93.5
In filtered water in 1 c.c.	1.0*	7.9*	5.2†	3.0‡
In filtered water in 100 c.c.	66.0*	65.0*	84.3†	51.6‡
Percentages of presumptive positive B. coli results in 100 c.c. of filtered water for the period of disinfection:				
Before disinfecting filtered water	....	....	88.9	89.3
After disinfecting filtered water	....	....	12.8	27.7

*No sterilizing agent used.

†Disinfection with calcium hypochlorite for first three months of 1911.

‡Disinfection with calcium hypochlorite for first six and one-half months of 1912.

*Slightly condensed from the "American Journal of Public Health" for December, 1913.

†Superintendent of Filtration, Cincinnati, Ohio.

Tallulah River Development of the Georgia Railway & Power Company

SYNOPSIS—Unique features of design and construction on an important Southern power development are shown. Provision is made inside the impounding dam for a 6000-kw. power station, utilizing the flow needed for river regulation. The diversion dam is an arched gravity-section design carrying automatic flashboards and a highway bridge on piers above the crest. Water is carried through 6663 ft. of tunnel to the penstocks which drop down a steep bank to the power station 600 ft. below. The turbines are high-head, high-speed, vertical-shaft Francis units, with all rotating parts supported in thrust bearings on top of the generator frames.

One of the most important southern hydro-electric developments of recent years has very recently been placed in service at Tallulah Falls, near Atlanta, Ga. Briefly, the development, as shown in Fig. 1, consists of (1) a storage reservoir some six miles above (2) a diversion dam close by the town; (3) a tunnel 6670 ft. through rock from the intake to the forebay; (4) five (six ultimately) 5-ft. steel penstocks 1200 ft. long, and (5) the power station containing five (ultimately six) 10,000-kw. units operating under an average head of 600 ft., with vertical-shaft Francis-type turbines.

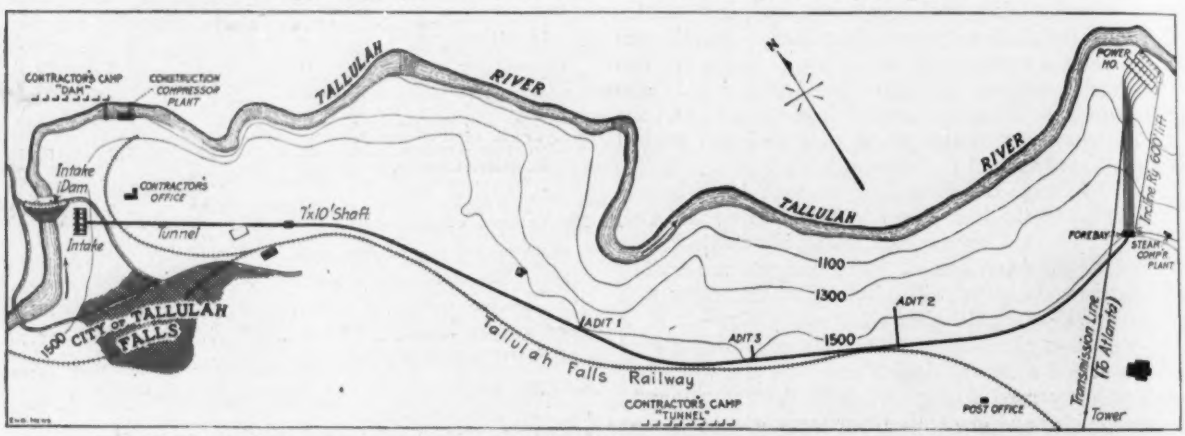


FIG. 1.—MAP PLAN OF THE TALLULAH RIVER DEVELOPMENT OF THE GEORGIA RY. & POWER CO.

STORAGE DAM—The storage reservoir, 7 miles above the intake and known as Lake Stevenson, has a capacity of 1,250,000,000 cu.ft. Here is the so called Mathis dam, which is a reinforced-concrete Ambursen type, 90 ft. high and 700 ft. long. There are in reality two dams, a main one of the dimensions given and another, about 300 ft. long, a mile upstream of the main structure, serving as a dike across a narrow side outlet of the reservoir. There are 22 buttresses, 18 ft. c. to c., in the main dam carrying a reinforced-concrete deck on their upstream faces. This deck is a series of arched slabs, the face of the slabs being flush with the faces of the buttresses; the thickness at the crown of each arch is 39 in. at the bottom and 18 in. at the top. A cutoff wall extends from the toe of the deck down to rock 10 or 15 ft. below the ground surface. The spillway deck and apron are also of reinforced concrete, designed to facilitate the passage of floods and to protect the buttress footings. About 100 ft. below the dam a wall has been built to form a pond, some 15 ft. deep, backing up against the downstream face and absorbing the shock of the spillway discharge.

Rising above the crest, 16 ft. apart, are piers, 2 ft. thick and 12 ft. high. These will carry a foot-bridge and permit the use of automatic flashboards if desired.

There will be three 48-in. hydraulic gate valves for river regulation or for draining the reservoir. The flow will be sent through two 3000-kw. generating units, delivering energy over short connecting circuits to the main generating station below.

DIVERSION DAM—The diversion dam is a rubble-concrete arch but of gravity-type section. The maximum height is 135 ft. and the footings are on solid rock varying from 10 to 20 ft. below original ground surface. The total length of crest is 444 ft., and of this 280 ft. is effective in spillways. The dam is arched upstream with a radius of 900 ft., but this shape did not enter the stability computations more than as it may increase the factor of safety over the designed value.

The dam is of particular interest in addition because the piers, which rise above the crest and divide the spillway into ten 28-ft. sections, are used to support the inclined tracks of automatic flashboards (Stauwerke type) and a highway bridge. The latter was made necessary since the impounded water flooded an old road.

These flashboards, the first in America of this type, are timber-faced steel frames between the piers, hinged at the lower edge and with cables from their upper corners running to drums on a heavy cylinder which rolls up and down an inclined track as shown in Figs. 2, 3 and 4. When the boards are down they fit into recesses on the crest and when they are up they are inclined at an angle of 35° with the vertical in order that trash may be swept over when the top is under water. The counterweights are reinforced-concrete cylinders 26 ft. long by 3¼ ft. in diameter. The rollway track is a rack in which cog-wheels run. There is, a stop, of course at the lower end of the track where it bends into a horizontal plane.

As the pressure of the water forces the flashboards down, the counterweights are rolled up the inclined track by the pull of the steel cables unwinding from the drums

at either end. The gates are designed to maintain normal height of backwater within 3 in. when passing a flood of 12,000 sec.-ft.

Twelve sets of small hand-hoisting gears have been placed on the parapet of the bridge to furnish the necessary extra force required to operate these automatic flashboards by hand when such control is desired. Small drums carry a cable which leads down to the ends of the counterweight; each drum is worked by a crank through worm and gear.

Only six of the spillway sections are fitted with these automatic flashboards, the other four having boards of the ordinary type designed to give way when they are overtopped by 2 ft. of water.

The highway bridge has a 12-ft. roadway and is made with two 3-ft. steel-plate girders at the sides embedded in concrete; four concrete floor beams support the roadway between each pair of piers. There are several expansion joints in the bridge; these allow the main girders to slide on plates at occasional piers, each roadway thus preventing collapse when the intake is empty.

The girder is 5 ft. wide, 4 ft. thick at the crown and 6 ft. at the ends. It has its top about 3 ft. above low-water elevation in the reservoir. The rear lower corner of each division wall is cut away to form a transverse passage 23½ ft. high and 11½ ft. wide, giving common communication from all chambers to the tunnel entrance which is at the center of the rear wall.

At the thrust-girders are the screen racks, made up of ⅜x4-in. flat bars placed 1⅝ in. c. to c., on 12-in. I-beams and inclined at an angle of about 23° with the vertical. Three chambers have a continuous screen from top to bottom, with motor-operated rakes to keep them clear. The other two chambers have the screen in two sections, one sloping down from the front of the thrust-girder and the other inclined up from the back. This gives a 5-ft. platform for hand raking.

In front of each chamber are 8x10-ft. steel gates, each lifted by two 8-in. steel I-beams carrying racks engaging the gears of the hoists on top of the structure.

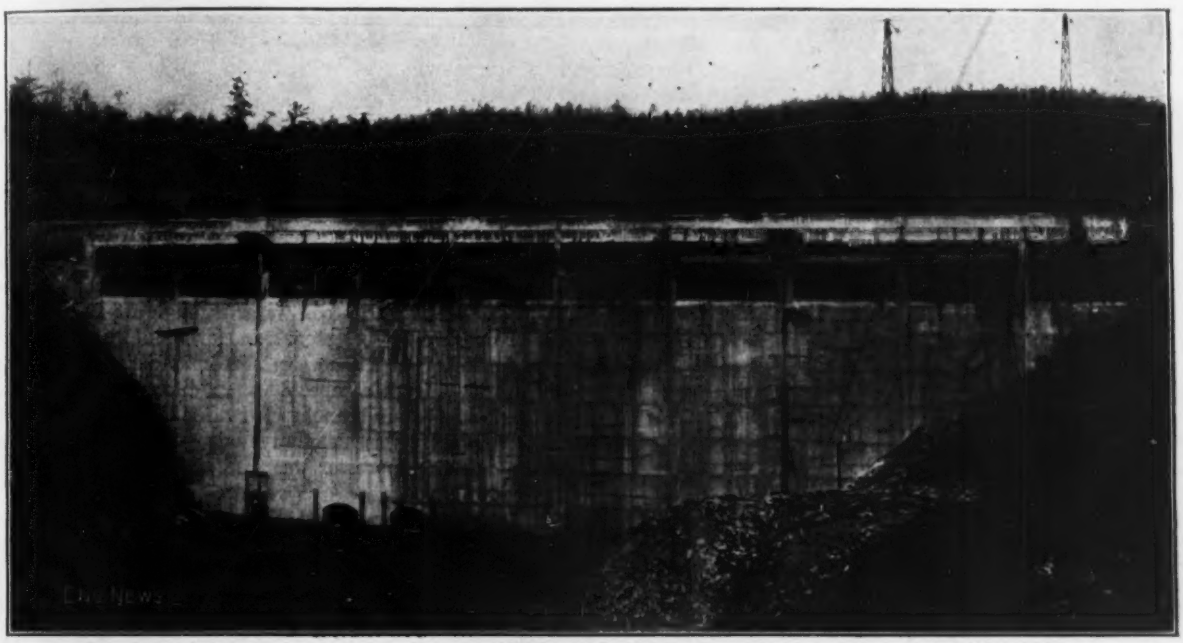


FIG. 2. THE TALLULAH DAM NEARING COMPLETION

end section being supported by an I-beam surmounted by a Z-bar which carries a copper diaphragm seal.

Near either end of the dam is a gate, as shown in Figs. 2 and 5, for sluicing out any collection of sand. These are operated from small platforms on the bridge.

The concrete was a 1:3:6 mix, there being about 38,000 cu.yd. including the embedded boulders. This concrete was placed at a rate of about 800 to 1000 cu.yd. per week.

INTAKE—On the east bank of the river, just upstream from the dam, is the intake and this forms the entrance to the tunnel. It is a reinforced-concrete structure 62 ft. wide by 44 ft. high in front, and 38 ft. from front piers to rear wall. Concrete division walls, 3 ft. thick, separate the intake into five chambers. The division walls extend forward of the intake chambers to form piers. A reinforced-concrete arched thrust-girder spans each chamber, 22 ft. below the top and near the center,

The bottom of the tunnel is 51½ ft. below the top of the intake, 46½ ft. below high-water elevation, and 26½ ft. below low water in the reservoir, so that the tunnel is always under at least 12½-ft. head. The bottom of the intake chambers slopes up to the gates, the bottom sill of which is 9½ ft. above the bottom of the tunnel.

TUNNEL—The tunnel, as shown in Fig. 6, is horse-shoe shape, 14 ft. high, 12 ft. wide, with a top-arch radius of 6 ft., and a sectional area of 151 sq.ft. The tunnel is designed to have a maximum rating of 1555 sec.-ft. with a water velocity of 10.3 ft. per sec. The normal flow with full load on all units in the station below is 1160 sec.-ft., and a velocity of 7.7 ft. per sec.

The minimum thickness of concrete lining is 18 in. and this material was put into the forms with a Mac-Michael pneumatic pipe carrier; the sand, cement and stone were mixed dry at a maximum distance of some 1000 ft. from the work and, with the necessary water,

FIG. 3. UPSTREAM VIEW OF TALLULAH DAM, SHOWING COUNTERWEIGHTS OF STAUWERKE FLASHBOARDS

forced by compressed air to the more or less distant points. About 18,000 cu.yd. of 1 : 3 : 5 concrete was used. The forms were steel.

In the construction of the tunnel, one 10x12-ft. shaft, 100 ft. deep, and three 7x13-ft. adits were used, the shaft being 1283 ft. from the entrance portal and 1443 ft. from the first adit. The distance between the first and third adits was 1443 ft.; between the third and second adits it was 1011 ft., and from the second adit to the discharge portal was 1460 ft. Various schemes of working were tried but for the most part a heading 8 ft. high for the entire length of a section was made, after which the bench was excavated. Some special timbering was required in places, delaying the work beyond schedule time. The total excavation was some 60,000 cu.yd.

COMPRESSOR PLANTS—The rock excavation in the tunnel and for the dam required much compressed air, so that a temporary hydraulic compressor plant was built downstream from the tunnel entrance, as shown in Fig. 1. Here a timber dam 60 ft. long and 8 ft. high was thrown across the river, securing an effective head of 48 ft. Eighty feet of 7½-ft. steel penstock brought the water down to a 1000-hp. turbine which drove two air compressors rated to furnish 2500 cu.ft. of free air per minute. A second turbine also took water through a 3-ft. penstock and drove two 50-kw. generators for tunnel lighting. Air was furnished at 110-lb. pressure and distributed along the work through a pipe, 8 in. in diameter at first but reduced as various branches led off. The amount of air from this plant was not always enough, so an 1800-cu.ft. steam-driven compressor was installed on the bluff above the power house.

FIG. 4. TALLULAH DAM AND INTAKE UNDER CONSTRUCTION

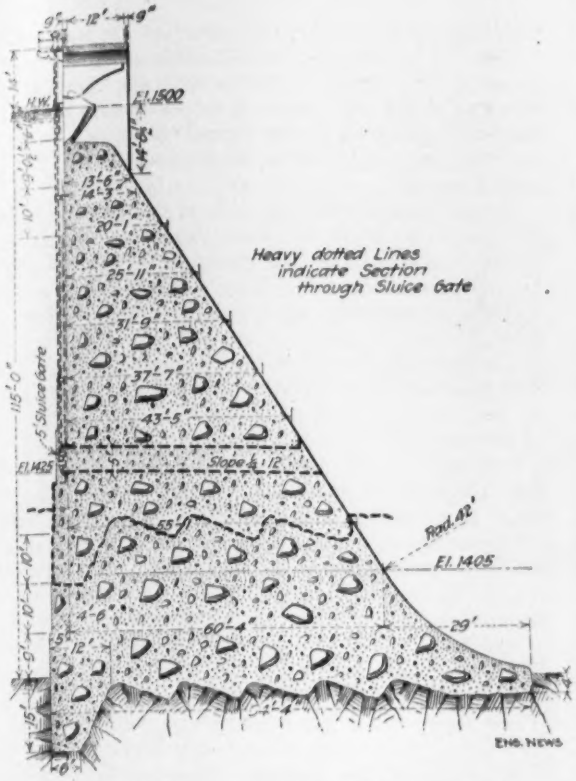


FIG. 5. SECTION THROUGH TALLULAH DAM

At the discharge end of the tunnel, an inclined railway (cable hoist) was built connecting the power-house site with a railway spur. This greatly facilitated the transportation of pipe and machinery for the station, 600 ft. below (in elevation).

FOREBAY—What is called the forebay, at the lower end of the tunnel, is merely a surge tank, 30x71 ft. inside and 93 ft. high, only 30 ft. of which is above ground. Virtually, it is a cross-tied steel frame, capable of bearing the entire pressure stress, set in a rock excavation and embedded in concrete walls which are relied on, however, only to hold the water and to transmit stress to the steel.

It has no storage capacity more than to absorb the temporary tunnel flow if all the gates were shut with 25% overload on the six turbines. The forebay water level is estimated to be 12 ft. below intake level at this load and the rise is expected to be 41 ft. maximum.

In front of the entrance of each penstock in the forebay wall is a steel flap gate 7½ ft. square, hinged at the top and held open by a chain passing through a hand hoist on the top of the forebay. This gate is intended to act as an emergency stop in case of such accidents as the breaking of a penstock, etc. Any sudden rush of water larger than due to operation would exert such a force on the gate that the chain would be broken and the leaf released.

PENSTOCKS—Only five of the six penstocks have been placed. These are of riveted steel for the upper half of the run and imported welded-steel pipe below. The thickness varies from ⅜ in. to $\frac{9}{16}$ in.; and the lengths run from 1200 to 1258 ft., according to the position of the turbines (see Fig. 1). The grades exceed 70% and the maximum is 150%. Just outside the penstock portal are 60-in. motor-operated gate valves controlled from the power plant. The contactors for operating these valves are assembled in a little house just above the valves. There is one 16-in. air valve in the top of each pipe; the pipes are thick enough to resist collapse at distances below the influence of the vents.

FIG. 6. TUNNEL ENTRANCE

FIG. 7. POWER HOUSE, PENSTOCKS AND FOREBAY

The penstocks are anchored in heavy concrete piers at each change in grade and at intermediate points are supported on concrete saddles about 32 ft. apart.

At the lower end of each penstock is a heavy steel anchorage casting embedded in the power-house foundations,

FIG. 8. VENTURI TUBE IN A PENSTOCK

connecting with the turbine casing and designed to hold the penstock thrust off the wheel cases. A hydraulic gate valve is placed between each casting and penstock. This gate has an operating valve designed to hold the gate in any desired position; the main valve is marked by penstock pressure.

Each penstock, just before it goes under the station buildings, becomes a Venturi meter by the insertion of a 35-in. throat (see Fig. 8). The indicating and recording instruments connected to the meter are located on the rear wall of the transformer house. These are for checking wheel efficiencies during normal operation. An excellent weir has been built in the tail-race channel for the same purpose.

POWER STATION—This consists of two large buildings, the generator house and the high-tension house connected by a smaller central structure so that the aggregation forms a letter H. This has been found to be a desirable arrangement here as light is admitted on all sides.

The generating house is 192 ft. long and 48 ft. wide. The transformer and high-tension switch house is 250 ft. long by 50 ft. wide, with its front wall 28 ft. back of the rear wall of the generating house.

The foundations of the generator house are of cyclopean concrete, the walls being carried 1½ ft. above the main floor, which is built with the sidewalls in monolithic construction. The basement (turbine room) is divided, by long piers 5 ft. thick, into 28-ft. chambers which, however, intercommunicate by three openings through each pier. From pier to pier, along the length of the building are thrown two 5-ft. steel-plate girders. These are cross-connected a few feet either side of the center of each span by two short 5-ft. plate-girders. These support the generator frames and in turn the rotors; the floor between the long girders is filled with 5 ft. of concrete for stiffness. Between the girders and the walls the floor is a lighter slab. In this way the wall footings carry none of the main machinery load.

The building frame is of steel with red-brick curtain walls. Window sills and pilaster caps are of marble. The roof is of the usual A-shape, but has a monitor along nearly the whole length of ridge. The roof is covered with large (30-in. wide) reinforced-concrete tile, colored red, and resting directly on steel purlins spaced 4 ft. apart and sealing water-tight. The principal entrances have rolling-lift steel doors.

A gallery, with a stairway at each end, runs along the back wall of the generator room and forms the ceiling of the rheostat compartments. From this gallery,

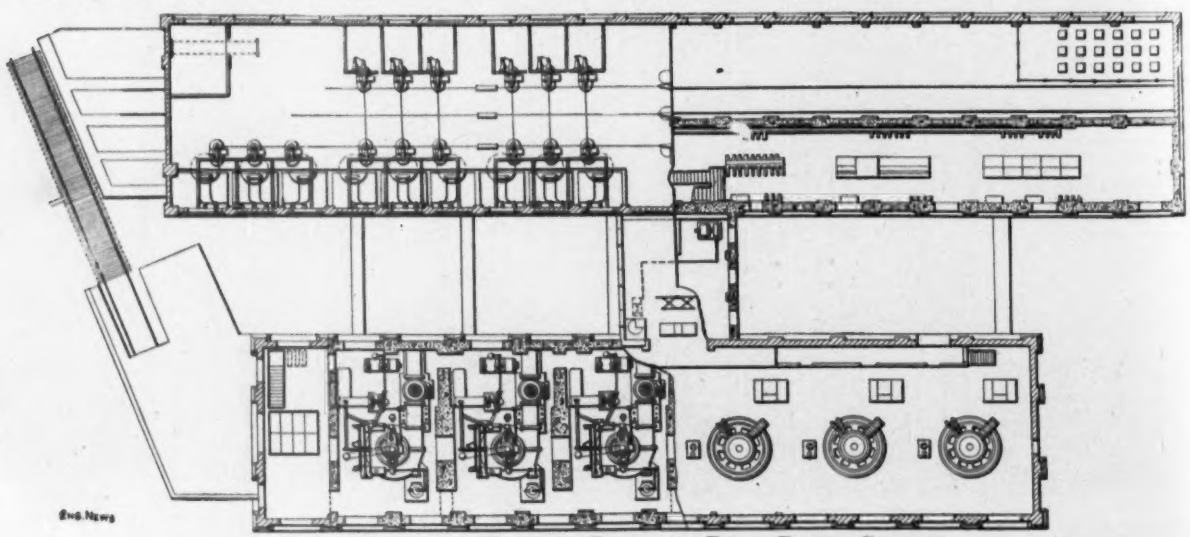


FIG. 9. SECTIONAL PLAN OF TALLULAH RIVER POWER STATION

which leads to the control board, the operators have a good view of the whole operating floor.

Below the main floor of the generating room are the turbines, each unit complete with pressure pumps and gate-controlling mechanism, as shown in Figs. 9 and 10.

The turbines were designed to develop 15,000 hp. each at 514 r.p.m. under a head of 600 ft.; they have carried 18,000 hp. The shaft is vertical and the runner, of Francis type, is surrounded by a spiral case. There is a heavy downward thrust at full load. The gate operating ring is fastened to a horizontal yoke, which is worked by twin cylinders under the control of an oil-pressure governor. On an extension of the penstock connection is a balanced relief valve, which is opened by a governor rod working through a dashpot so that the valve closes gradually and is followed by a recovery movement of the governor connection. Some 70% of the turbine flow at any load is thus by-passed, the relief closure being made in 45 seconds.

The turbine casing is of cast iron; the runners are of bronze; the gates are of forged steel with bronze-bushed pivot bearings and bronze-lined packing glands. The draft tubes are of steel plate concreted into foundations. The normal draft head is 22 ft.

Besides the oil-thrust bearing which supports the rotating parts, there are three guides, one just above the turbine runner, one just below the generator armature and one just above. The shaft is of nickel steel, made in two main sections, with flange connection between the wheel and generator; the exciter armature is carried on a stub shaft extending up from the top section. The load of the combined rotor (about 75 tons weight and 20 tons maximum thrust) is transmitted from the thrust bearing to a heavy end-plate spider of the generator frame, which in turn is supported on the main floor. Each turbine unit is equipped with its own governor and oil pump for the thrust bearing, though these pumps are interconnected.

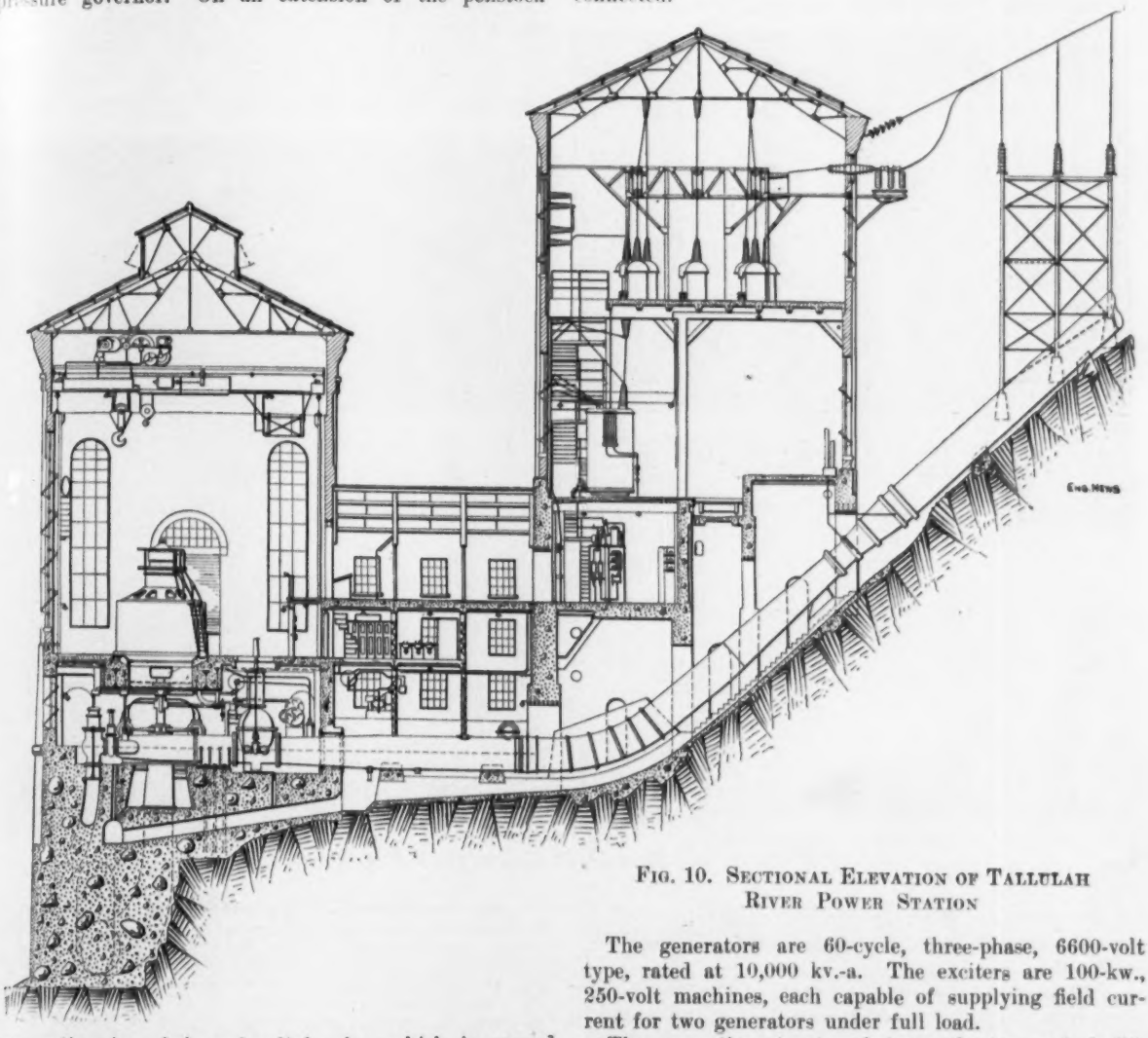


FIG. 10. SECTIONAL ELEVATION OF TALLULAH RIVER POWER STATION

The generators are 60-cycle, three-phase, 6600-volt type, rated at 10,000 kv.-a. The exciters are 100-kw., 250-volt machines, each capable of supplying field current for two generators under full load.

The connecting structure between the two main buildings has its upper floor at the gallery level and here is the control bench-board for generating apparatus and high-tension switches. This floor also leads to the low-voltage switching room of the high-tension house.

On the first floor of the switch control house, is a 250-kw. Pelton waterwheel fed from the penstock and driving an auxiliary exciting generator for emergency use and for lighting (but connected to the exciter bus). There is here, also, a small motor-driven air compressor for cleaning and other services about the station. The second floor of this small building is at the same eleva-

tion as the generator main room, and contains lavatories and lockers for the operating force.

The switchboard for the exciters is on the main floor of the generating room, back of the center, although directly opposite each generator below the gallery is a panel for the field-rheostat handles, the remote-control field switch and the operators' signal for that machine. The several generating units are isolated but there is a 6000-volt transfer bus for inter-connection. Three sets of individual busses for each machine allow it to be thrown on the transformer bus, on its own transformers directly, or on the transfer bus. Each generator has three 3333-kv.-a. single-phase transformers, increasing voltage from 6600 to 63,500 volts. When these trans-

FIG. 11. GENERATOR ROOM OF TALLULAH STATION (UNDER CONSTRUCTION)

formers are Y-connected, the line potential between any two is 110,000 volts, at which power is transmitted. From the high-voltage terminals, the current is led out through high-tension oil switches and busses.

The high-tension house is similar in construction and appearance to the generating house, except that the roof has no monitor and the trusses are of special design with raised chords, leaving space for the necessary high-tension busses, without excess height of wall.

The 110,000-volt bus wiring is carried out through a new design of bushing, which requires no protection from weather besides itself. Outside of the building is an extension of the 110,000-volt bus, by which it is possible to make working connections in case of trouble with bushing, inside insulators, etc The electrolytic lightning arresters, horn gaps, etc., are on a steel structure placed on the side of the hill adjoining the switch house. Nearby is the elevated tank for transformer cooling water (Fig. 8).

TRANSMISSION LINES—The main transmission line runs from this plant to Atlanta, a distance of 90 miles. There are two extensions from the Atlanta substation; one, 80 miles to Lindale, and one 50 miles to Newnan. The main line is a double-circuit arrangement of No. 0000 solid copper wire, suspended in a vertical line on 9-ft. centers, three on each side of a tower. The top of each tower supports two $\frac{7}{16}$-in. stranded galvanized-iron ground wires. The insulators are of suspension type, made up of four disks. The towers also carry a telephone circuit made up of No. 4 copper-clad iron wire on 15,000-volt insulators.

Three sizes of standard type towers are used, 66, 70 and 80 ft. in height, with square bases and 16, 20 and 18.5 ft. on the side, respectively. The first height is used on the main line, the second on the two extensions noted, and the third is for carrying high- and low-tension circuits in the outlying districts of Atlanta.

The crossarms are standard channels and the tower legs are angles. Footings are made by extending the tower corners seven feet and bolting footing angles to the bottom ends. The legs are in concrete foundations. For angles above 10°, special towers of heavier section were used; these have eccentric crossarms to provide line clearances. A few special towers, 105 ft. high, are used, over railway crossings, etc.

The substations are of semi-outside type—with the transformers, high-tension switches, lightning arresters, etc., of outdoor type, without further protection against the weather, but with the control panels in an operator's building. The high-tension wiring has been strung over

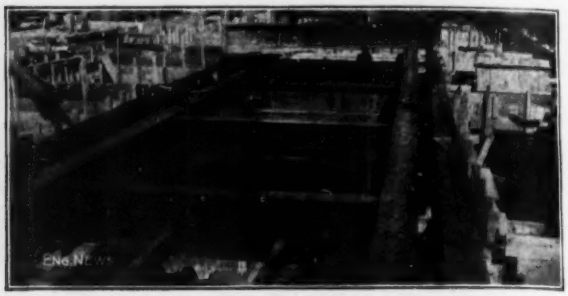


FIG. 12. STEELWORK OF GENERATOR ROOM FLOOR; TALLULAH FALLS PLANT

the apparatus with supports from standard construction on steel towers. The low-tension lines from the transformer are run on supports in two subways, which extend the length of the station and communicate with the basement of the operating house. In this house are also the low-tension switches.

DESIGN AND CONSTRUCTION—The turbines were made by S. Morgan Smith Co., of York, Penn.; the main electrical equipment was furnished by the General Electric Co., of Schenectady, N. Y.

The several parts of this development were designed by C. O. Lenz, as Chief Engineer of the Georgia Ry. & Power Co. The construction was carried out by a subsidiary concern, the Northern Contracting Co., under Mr. Lenz as Chief Engineer of this company also.

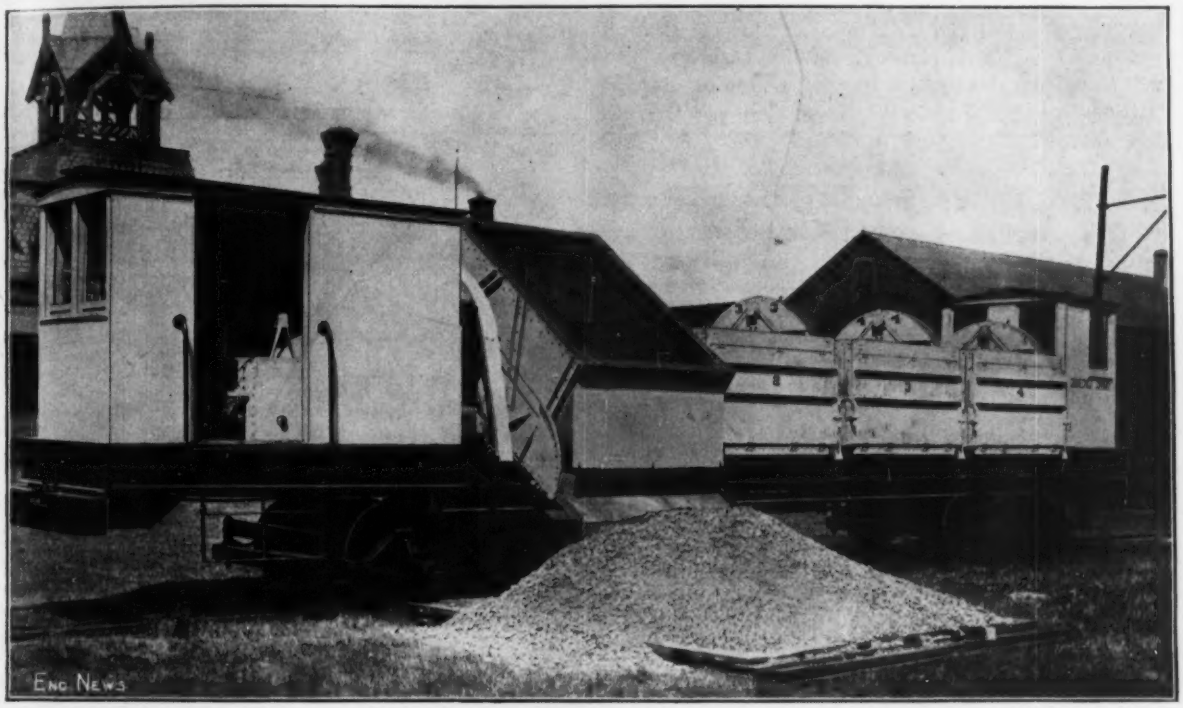
High Pump Efficiency was obtained in a duty test on a 9¼x24-in. Prescott Duplex Missabe Pattern Power Pump recently put in service for the Board of Water Trustees, at Dubuque, Iowa. The pump is driven at 52½ r.p.m. by a 150-hp., 580-r.p.m. alternating-current motor through a set of steel herringbone gears of ratio 11 to 1. The pump was specified to handle 2,000,000 gal. of water per 24 hours against a total head of 340 ft. and with a pump efficiency of not less than 85%. A report of the test follows:

Average r.p.m.		50.23
Area of plunger in sq.in. net		64.746
Gallons per revolution $\frac{64.746 \times 24 \times 2 \times 2}{231}$ =		26.9
Gallons per minute 26.9 × 50.23		1351.18
Average discharge pressure	lb.	117.5
Average suction lift 6.2 ft.	lb.	2.69
Distance between gages 4 ft.	lb.	1.73
Total working pressure	lb.	121.92
Average delivered hp. $\frac{1351.18 \times 121.92}{1714.5}$ =		96.2
Input in kw. to motor		86.2
Input in hp. to motor		115.3
Overall efficiency $\frac{96.2}{116.3}$ =		83.5%

Multiple-Body Electric Dump Cars

The Connecticut Co., operating a network of electric railways in Connecticut, in 1912 was led to undertake the hauling of road-making material over some of its lines, with notable reduction in some local costs of highway construction. In order to handle this business the company was obliged to use its old dump cars, but this was done with misgivings on account of their unsightly appearance. At the suggestion of the State Public Utilities Commission a new type of car was developed.

Early in 1913 the engineers of the Connecticut Co. and the Wason Manufacturing Co., car builders of Springfield, Mass., met to devise some sort of a dump car which would not only do the work effectively, but quickly and economically. The result of these conferences was the design shown in the accompanying figure. They are termed "multiple-body dump cars," each car having four separate dumping sections. Five of these cars were delivered and put in service on the company's lines, at New Haven and Hartford, hauling crushed stone for new roads.



MULTIPLE-BODY ELECTRIC DUMP CAR OF THE CONNECTICUT CO.

The capacity of each car is 24 cu.yd. of crushed stone (64,000 lb.), each compartment carrying 6 cu.yd. The weight of each car, with maximum load, is 72 tons; unloaded, 21 tons. The dimensions are as follows: Length over all, 48 ft. 10 in.; height to top of cab, 11 ft. 3½ in.; width, 8 ft. 5½ in.; truck centers, 27 ft. 6 in.

Each car carries four 40-hp. motors, on two standard trucks, driving a loaded car at approximately 12 miles per hr. Each car is equipped with air brakes. The cost of a car was a little over $6000, equipped ready for service.

In the cab is a 10-hp. motor, used for tilting the body compartments in unloading. This is done by hauling in on the proper cables attached to the lower corners of the compartments and running over sheaves in the intermediate (vertical) frames (3-3 and 4-4 in the accompanying figure). Each body section tilts on corner hinge pins in open-top pockets on the main frame so that the car will dump over either side. Dumping is done with such rapidity and smoothness that the observer is necessarily impressed with the ease of handling the car. The mechanism is so designed that it will dump all four compartments at once, or one at a time, as desired. It takes less than one minute to unload each car when compartments are dumped one at a time.

These cars are operated with only two men, a motorman and a brakeman. This feature alone is a saving of 50% in platform labor. On the old-style dump cars, where one motor car was employed to haul four small dump cars, there were required the services of a motorman, a trolley tender and two brakemen. In unloading the old dump cars, it was the duty of the two brakemen to unfasten the chains and raise the side boards—time and labor which is now done away with. Then again, parts of the load were deposited on the track, so that additional time was required to clear the way for the train. In the new cars, as the load is dumped, the compartment side extends out, throwing the load clear of the track and car. The crew is not required to leave the car and the moment the load is delivered the motorman turns on power and the car is off on another trip.

In the operation of the old five-car trains, a great deal of switching was necessary at the quarry in order to get the cars in a position for loading. While in transit through the streets, they swayed dangerously and were a menace to public safety, the danger being that at times parts of loads, or even the entire load of a car, would be

dumped in the streets. The new car requires no switching as it is easily and quickly run up into position for loading, while in running through the streets it is not attended with the rumble and roar of old. Another objection to the old method, aside from the noise and danger of accident, was the fact that the people did not want a train of cars operated through the city streets. The new car dissipates this nuisance, inasmuch as it cannot now be considered as a train but only as a street car.

In the maintenance of track and equipment, the saving has been very great. By the old method, five units were employed; with the new car there is one unit with the result that there is less wear and tear on track and special work and less equipment to be kept in repair. The economy is clear when it is shown that the capacity of the one new car is much greater than the five old dump cars, and when it is also understood that the new cars are making three trips to one of five-unit trains.

There are no other cars of this type known, these having been designed and built especially for the Connecticut Co. It is likely, however, that the next cars, which will be ordered shortly, will be built with only three compartments but with practically the same carrying capacity.

Laying Brick Paving on a Street with Level Grade

By Jent G. Thorne*

A plan devised by the writer for pavements in streets having a level grade is shown in the accompanying cut, which represents a block of pavement in 2d St., at Clinton, Iowa. The street has water, gas and sewer mains, and a double-track street-car line.

The total improvement included 36,576 sq.yd. of vitrified block pavement and 11,175 lin.ft. of combined curb and gutter. The pavement has a 6-in. concrete base, made with 1 part of cement to 6 parts of Mississippi River gravel, the gravel being so graded as to form a 1:2:4 mixture. Upon this a ½-in. sand cushion was spread for the vitrified repressed-block paving. Asphalt filler was then poured into the interstices from special pouring pots. The contract was let Jan. 14, 1913, to the Ford Paving Co., Cedar Rapids, Iowa, at $1.98 per sq.yd. The work was commenced Apr. 1, and was completed about Sept. 20, 1913.

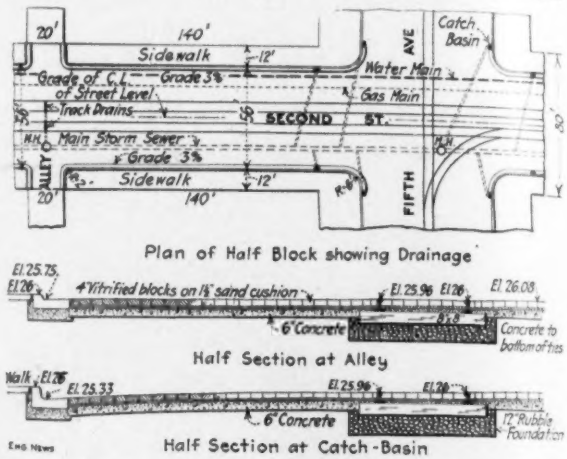
The chief points of interest during the construction of this pavement were as follows:

1. A 10-min. car service each way on double track and an exceptionally heavy street traffic made it necessary to keep one side of the street open to travel at all times.

2. The level grade in the center of the street and 8 ft. on each side of the center made it necessary to create a fall for drainage by varying the depth of the curb face. This depth is 3 in. at the alley (in the center of the block) and 8 in. at the catch basins at the corner of the block. This arrangement made a warped surface of that part of the pavement between the rails and the gutter, thus making it impossible to shape the sand cushion with a template resting on the gutter and the rail in the usual way. The guide boards were set running from the rail to the gutter and the sand was then dragged with a straight-edge from the rail toward the gutter. The following table shows the drops at the various points in each half of the block; the figures giving the distance below the inner rail, which is on the established center grade:

	Outer Rail	6 Ft. 6 In. Out	13 Ft. Out	Edge of Gutter
Alley line	0.04	0.06	0.10	0.16
¼ point	0.04	0.075	0.15	0.26
½ point	0.04	0.09	0.205	0.36
¾ point	0.04	0.105	0.25	0.46
Catch basin line	0.04	0.12	0.29	0.56

3. Owing to the fact that the street is in the principal business district, and the sidewalks are only 12 ft. wide, it was impossible to pile the brick alongside the curb as is usually done. The contractor used the economical scheme of hauling the brick to the job at the time of laying, thereby eliminating one handling.



Plan and Sections of a Brick-Paved Street Built on a Level Grade

4. The brick was tested in the new style paving rattler adopted by the National Paving Brick Manufacturers Association. Samples from each car were tested and accurate records of all tests were kept. The cement was tested for tension, fineness and time of setting, a sample being taken from each carload. The asphalt was tested from time to time in a chemical laboratory.

*City Engineer, Clinton, Iowa.

Is Heavier Design Needed in Railway Bridges?

In the last five years, many railway bridges built less than 25 years ago have been removed and replaced by much heavier bridges. This strengthening process was only one step in a long series; ever since the early days of railway bridges, the continually increasing weight of locomotives and trains made bridges obsolete long before they rusted or wore out. The history of railway bridges has been a record of evolution from light to continually heavier bridges. At various times in this evolution, bridge engineers decided that the weight of trains then in use was substantially the maximum that could ever be expected on our railways. The event proved them wrong.

The same question is now again being considered quite widely. A noteworthy contribution to the subject is made in the November, 1913, Bulletin of the American Railway Engineering Association, where various bridge engineers discuss the subject.

J. E. Greiner (Consulting Engineer B. & O. Ry.), in a paper entitled, "Rolling Loads on Bridges," says:

Eleven roads are building bridges for a strength practically equal to E60,* four for E57, seven for E55, one for E53, eleven for E50, four for loads under E50, and one for loads over E60. Of those roads which are now designing bridges for E50 or under, two propose to change to E60, and three to loadings in excess of E50, in the near future.

* * We know from numerous tests and long experience that bridges properly designed and constructed of proper material and with members proportioned in accordance with specifications equally as good as the standard adopted by the American Railway Engineering Association, so long as maintained in good condition, will safely withstand an overload of 50% without any traffic or speed restrictions; that such a bridge may be subjected to an occasional overload considerably in excess of 50%, and this without speed restrictions; and if the speed is regulated, the bridge will stand an occasional overload of 100%. This statement is consistent with the writer's personal experience in the maintenance of structures in the past 25 years, and is somewhat more conservative than has been the successful practice of a number of railway engineers.

* * It appears [from figures and arguments not here reproduced—EDITOR] that an E50 bridge is a good and economical type and provides for increased loading * * until such time as conditions require practically a complete reconstruction of the railway. * *

The tendency toward the adoption of E60 loading is perhaps influenced more by precedent than by good sound reason and judgment, and is being stimulated by the bridge companies, who profit by a greater tonnage of metal used in construction. The writer hopes it will not be inferred that he condemns E60 bridges as unreasonably heavy and extravagant, and therefore not consistent with economical construction.

An E60 bridge is heavier, stronger and stiffer than an E50 bridge, and its construction will cost from 12 to 15% more. It will safely carry the heaviest load that it is possible to conceive of, but if the weight of engines ever increases sufficiently to develop its capacity, bridges as now constructed will probably not give sufficient clearance to enable such enormous locomotives to be safely operated.

E60 bridges would be more consistent if constructed with greater clear width and height than sanctioned by present standards, because this would provide for probable increased width and height, as well as weight, of the enormous rolling stock required to develop their capacity.

C. D. Purdon (Chief Engineer St. Louis Southwestern Ry.) states that he "agrees with Mr. Greiner generally." However, he points out that on shorter spans the locomotives in use today are equivalent to higher Cooper loadings than on longer spans. This fact was brought out by Mr. Purdon's diagrams of equivalent Cooper loadings for various actual present-day engines, published in ENGINEERING NEWS, Oct. 23, 1913, p. 825. These diagrams bring out clearly that Cooper's E50 loading is adequate, both as to shear and as to bending moments, to account for most locomotives on spans over 50 ft. For shorter spans, all locomotives become equivalent to higher Cooper loading, up to E65 or more for stringer spans of 10 to 15 ft. This could be recognized by making an extra impact allowance on short spans, to take care of the purely static effect of the locomotive load as compared with Cooper's loading. On the St. Louis Southwestern Ry., E50 loading is used for trusses and girders, and E55 loading for stringers, floorbeams and short girders.

John D. Isaacs (Consulting Engineer Southern Pacific Co.) states:

We do not think we would be justified at present in increasing the live-load for which our bridges are now designed. We agree with Mr. Greiner that a 50% increase in rolling loads without speed restrictions would be safe practice on bridges designed under American Railway Engineering Association specifications, but this percentage of increase could not safely be exceeded on bridges designed under ours.

As to using live-load E50 on low-grade lines and E60 on high-grade lines, and considering difference of speed, the necessity of frequently operating the heavier rolling stock over both high- and low-grade lines, and the advantage in cost and deliveries of minimizing the number of common standards, we think that all bridges on any given line, whether high- or low-grade, should be designed for the same live-loads.

J. P. Snow (Consulting Engineer, formerly of the Boston & Maine R.R.) agrees with the opinion that 50% higher stresses than those contemplated in the design are safe, and further says:

E50 bridges will carry with reasonable safety anything that will be run on our present gage and clearances, and it is absurd to think of enlarging them. On the other hand, the writer believes our scheme of loading should be based on wheel spacing more consistent with actual practice than Cooper's series, so that a 50 loading, for instance, would more nearly represent a 50 engine.

A similar recommendation is made by H. Austill, Jr. (Bridge Engineer, Mobile & Ohio R.R.). He further says:

When bridges are designed for E60 it certainly would be well to increase the clearances now specified by the American Railway Engineering Association.

A. W. Buel (Consulting Engineer, formerly of the Western Maryland R.R.), referring to the same matter of clearances, says:

If the cost of increasing the clearances over an entire division should be too large a charge to incur, on account of tunnels, very large bridges or other limitations, it would then seem inconsistent to use a heavier loading than E50 for such divisions.

On the matter of the overload which a normal bridge will carry, however, Mr. Buel expressed conservative views:

With all the bridges on a road or division subjected to an overload of 50%, under the regular service traffic, the conscientious engineer in charge would be loaded with a great responsibility (more than a 50% overload) not desirable from any viewpoint, and if properly met the road would be loaded with an excessive cost of supervision and maintenance. If not properly met, the loss due to accidents might balance the account. If the element of guess in our impact formulas is not farther from the truth than is indicated by the still incomplete investigations on the subject, it is probable that a 50% overload would approach uncomfortably near the ultimate capacity of some members, particularly long columns.

It does not seem to the writer that it is extravagant to design new bridges for E60 loading where conditions justify the maximum, but he is in entire accord with the author that such bridges should be built with larger clearances than has been hertofore the common practice.

C. E. Smith (Asst. Chief Engineer, Missouri Pacific Ry.) concludes, from a review of development of live-loads, that a satisfactory method of design would be to use the maximum allowable stresses in the design, together with a loading sufficiently heavy to cover all future load developments. This recommendation is, of course, not new, and has been actually used in practice prior to this. Mr. Smith employs it, however, to reinforce his argument that the adoption of a more consistent scheme of live-loading than the Cooper series is greatly needed.

With regard to future increase in live-load, he apparently believes that whatever increase in locomotive weight may occur is likely to be accompanied by a corresponding decrease in impact, on account of the adoption of bal-

*The standard engine-and-train loadings recommended by Theodore Cooper for railway bridge design have the same wheel-spacing for all "classes." Thus, the widely used E50 loading consists of two consolidation locomotives with 50,000 lb. load per driving axle, 25,000 lb. on the leading axle, 32,500 lb. per tender axle, and the following axle-spacings, in feet: 8, 5, 5, 5, 9, 5, 6, 5, thence 8 to leading axle of second engine, and behind the second engine a space of 5 ft. to the front of a uniformly distributed load representing the train, weighing 5000 lb. per lin.ft. and continuing indefinitely.

The E40 and E60 loadings consist of weights respectively, 0.8 and 1.2 times those of the E50 loading, but with the same spacing; and other E-classes in similar proportion.—Editor.

anced types of locomotives, or electric locomotives. He finally concludes:

> The facts stated above, among others, have convinced the writer that bridges built for Cooper's E50 loading, according to the specifications of this association (impact = $\frac{300}{L + 300}$) and the basis of 16,000 lb. per sq.in.) are sufficiently strong to carry without restriction any loads that may ever come on them, and that no heavier bridges are necessary.
>
> He believes, however, that at slightly increased cost much more consistent bridges, having greatly increased strength, can be obtained through the use of more logical loading and unit-stresses in the design.

In the matter of the last mentioned recommendation, Mr. Smith argues in favor of abandoning wheel loads and using a uniform live-load with two excesses of weighing the same per foot as the uniform load, each 20 ft. long, 75 ft. apart.

As an "ultimate rolling load," he suggests a uniform loading of 9000 lb. per lin.ft., the excesses also being of 9000 lb. per lin.ft.

A Peculiar Column Failure

By C. I. Auten*

Carelessness in minor details has resulted in many major disasters. Particularly is this true of reinforced concrete, as its ultimate strength depends, in great measure, upon the care and skill used in its construction. The following incident illustrates this statement. The lesson drawn therefrom should be of service to engineers and contractors engaged in this class of work.

A column, under dead load only, failed as shown in the illustrations. It consisted of a reinforced-concrete footing and stub column upon which rested a structural steel column, fireproofed with concrete. This column supported a reinforced-concrete floor and a reinforced-concrete column that, in turn, supported a concrete roof.

The stub column was 22x22 in. in section, and was reinforced vertically with four ⅞-in. bars properly stayed. The concrete was a 1:1:2 mix. The stub column was designed to carry a dead-load of 100,000 lb., at about 2070 lb. per sq.in. Twenty days after the footing and the stub column were poured, the steel column was fireproofed and the next day the concrete was poured in the floor forms above. These forms remained in place for 26 days. Forty-six days after the stub column was poured, the column supporting the roof was constructed and the next day the roof forms were filled.

Sixty days after the stub column was constructed a fine hair crack appeared at point marked "*A*" in Fig. 1, and as it continued to enlarge, props were immediately placed as shown in the views.

The concrete continued to crack and five days after the first appearance of failure the four sides of the fireproofing around the base of the column were easily removed. The four sides of the stub column also came off in a similar manner to the fireproofing above. At no time was the settlement sufficient to cause cracks or any other sign of failure in the slab or beams above.

When the fireproofing split off, it exposed the bedplate of the steel column and also six small steel wedges that had evidently been used to shim up the plate on top of the concrete stub. Three of these wedges can be seen at "*B*," Fig 2, and three were located opposite them in a similar position. An ordinary folding pocket rule could be inserted for several inches between the bedplate and the top of the stub column.

It was apparent that the failure was caused by the use of these wedges. When the load came on the steel column, it was transferred to the stub by the wedges. They settled into the stub an appreciable distance, thus throwing the load onto the fireproofing. As this fireproofing was battered up from the 22-in. stub to the narrower column, it formed an angle with the column and the stub, and a horizontal thrust was developed which split off the four sides of the stub, the line of cleavage being uniform at about 3 in. in from all four faces.

The earth fill on top of the footing was removed and the footing found in perfect condition. All the loose concrete was taken off the stub and 8 in. of concrete poured around it on the four sides. This was reinforced with twelve ¾-in. bars hooped with ¼-in. rods at 4-in. centers. The tops of the rods were bent in close to the steel core. The top of this concrete extended for 14 in. above the base of the column.

*Bates Mfg. Co., Lewiston, Maine.

Fig. 1. Before Concrete Was Removed

Fig. 2. After Concrete Was Removed

Figs. 1 and 2. Views of a Concrete Stub Column Which Cracked from a Peculiar Cause

(Views are on opposite side of the column.)

Editorials

The passage of the "excess condemnation" amendment to the constitution of New York State last November promises to be of much assistance in the planning and financing of city improvements which require the taking of land for public purposes. By means of "excess condemnation," which in one form or another has long been practiced abroad, a city can take more land than is needed for the improvement itself and can subsequently sell the excess. This may sometimes save paying enormous sums for real or fictitious damages due to taking parts of many parcels of land and it may also assist greatly in readjusting lot lines so the excess property can be used to advantage, besides giving some measure of control over the character of the development of property fronting on parks, public buildings and important thoroughfares. Constitutional amendments permitting excess condemnation were authorized by popular vote in Ohio and Wisconsin, also, earlier in 1913, and the New York amendment was modeled after an amendment to the Constitution of Massachusetts approved by the people in 1911. Like constiutional amendments are needed in other states, as many city and consulting engineers can testify.

When the United States purchased the Panama R.R., or rather a controlling interest in the stock of the Panama R.R. Co., the purchase was made in order to obtain control of what was perhaps the most necessary tool for the construction of the Panama Canal. From the annual report of the Panama R.R. Co. just issued, it appears that aside from the extremely valuable purposes which the railway has served in connection with the canal's construction, its purchase has been a profitable investment for the United States. The United States owns the entire capital stock of the railway company but the corporate organization is maintained in all its details, its Board of Directors being made up of members of the Panama Canal Commission. The company even pays to the government a Federal income tax on its net profits exactly as if its ownership were in private hands.

The net profits of the Panama R.R. Co. in the last fiscal year covered by the report were in round numbers $2,180,000, representing about 31% on the company's capital stock of $7,000,000. Uncle Sam, however, does not use these profits to pay himself dividends, but allows them to accumulate as surplus. The total assets over liabilities now amount to over $15,379,000. About $1,600,000 of this surplus fund has been invested in bonds, mostly of railway companies.

It is fair to add that the railway is aided in making these large profits by its high rates for freight and passenger service. The average freight revenue per ton-mile last year was 3.48 cents. The average revenue per passenger-mile was 2.37 cents. The total length of the line is only about 50 miles, and, of course, the abnormal proportion of the operating expense absorbed in terminal charges justifies a much higher freight and passenger rate than in ordinary service.

The present plan is for the government to continue to operate the railway and its associated steamship line after the canal's completion. If the diversion of traffic to the canal makes the railway service no longer profitable, the Government can, if it chooses, so run the line as merely to pay operating expenses. The capital originally invested in it will have been fully repaid by the profits the railway has earned during the period of canal construction.

An engineer of wide experience both in municipal work on salary and in private practice raises a question of engineering ethics. Should engineers on city payrolls at presumably full-time salaries and with no private offices and no personal staff compete for outside work with engineers who have to maintain both?

In such cases the public official or employee has no office rent to pay, and if he has sufficient energy and executive ability, he can call to his aid his fellow employees and thus carry on a business of considerable magnitude practically clear of all charges except those for strictly personal services.

Two main points are more or less deeply involved: (1) The two-thousand-year-old question, "can a man serve two masters," with its well known and generally accepted answers; and (2) fairness of competition with engineers in private practice who must meet office rent and other overhead charges. The chief danger as regards unfair competition lies in the temptation to take advantage of lack of overhead charges and to offer to work for low fees in order to get more engagements or engagements more easily. This danger could be obviated by charging a standard fee—if there is such a thing that can be adjusted to various degrees of education, experience and ability. In so far as we have expressed an opinion on the first of the two points stated just above, it should be understood that we do not mean to suggest, much less lay down the rule, that under no circumstances should an engineer on a city payroll do no professional work out of hours at his own home or in a private office.

An Estimate Wide of the Mark

How should an engineer make up an estimate? Should he endeavor, to the best of his judgment, to hit upon a price that will be as near as possible to the cost of the work, or should he add to this a certain percentage, so that his estimate will represent the maximum possible cost of the work rather than the most probable figure?

In our opinion, if conditions were what they should be, an engineer's estimate should be the nearest possible prediction as to the final cost of the work. Under existing conditions, however, it is customary to consider the performance of work at a price below the engineer's

estimate as reflecting credit upon the engineer. Whereas, if the final cost is more than the engineer's estimate, the engineer comes in for more or less blame, direct or indirect.

Under these conditions, the engineer very naturally seeks to protect himself by making his estimates err on the side of liberality, and it is difficult to see how he can justly be blamed for so doing. If those who employ engineers wish to have estimates that will accurately represent the probable cost of the work, they will have to learn to use a greater amount of intelligence and common sense in judging the work of engineers.

A notable example of wide disparity between an engineer's estimate and the bids of contractors was recorded last week in Albany, when the bids were received for the new New York Barge Canal terminals at Buffalo. The principal item in this work, representing over four-fifths of the cost, is excavation, of which there are 1,222,000 cu. yd. On the Barge Canal contracts, the excavation is unclassified, but we are informed by a Buffalo engineer that on this contract the materials are approximately 75% earth and 25% limestone bedrock. The engineer's estimate for this excavation was $1.10 per cu.yd., which is certainly an astonishingly high figure when one considers how cheaply and rapidly both earth and rock are excavated nowadays, with modern machinery and methods. The four bidders on the contract bid the following prices per cu.yd.: 97c., 67c., 65c. and 51c. The total of the lowest bid was less than 60% of the engineer's estimate. It is true that at the present time contract work is scarce enough so that contractors are willing to bid very close in order to get work. Making all allowance for this, however, so wide a discrepancy between the engineer's estimate and the contractors' bids seems to call for criticism. Ae we have said above, an engineer may reasonably make his estimates liberal to cover the contingencies which may lead to an excessive cost. A point is reached. however, where his estimate becomes so far out of proportion to the cost of the work that it becomes misleading and useless.

Cheap But Costly Municipal Engineering

The poor economy of giving important engineering work to the man who offers to do it at the lowest price, without regard to the importance of the work or the experience of the engineer, has been pointed out many times. The practice still exists, however, even in municipalities which might be assumed to have officials who would recognize their responsibility in protecting the interests of their constituents and of the city. It has been pointed out, also, that this unintelligent policy is confined usually to engineering work. In legal matters affecting the same work, expert and high-priced lawyers are employed freely, and there is probably hardly any municipal officer who would favor the employment of a lawyer merely because he offered to attend to the legal affairs of the city at a low price.

The above statement of an old but too frequently recurring feature in the control of municipal engineering work is suggested by an example which has been recently brought to our attention. A sewerage system was desired for a certain section of a city, at a cost of about $400,000, and the city authorities invited engineers to bid on the work, these bids to be divided thus: (1) making preliminary plans and estimates; (2) preparing detailed plans and specifications; (3) attending meetings of the Council and making comparisons of the bids. The designing engineer's services were to terminate with the letting of the contract, the construction work being attended to by the city engineer. A consulting engineer offered to do the whole work for 2% of the contract price, with a fee for the first step of $1000. If the work proceeded, then the preliminary charge would be assessed as part of the cost. If, however, the district affected voted against the project, the preliminary fee would be paid from the general fund. The City Council, therefore, wanted the preliminary fee to be as small as possible. Other engineers made similar propositions of about 2%, but with the preliminary fee less than $1000. Two engineers of experience and reputation looked the ground over carefully, and found the system offered some difficult problems demanding close study if the best results were to be secured for the city. They made a joint proposition to prepare the preliminary plans and estimates for $3000, and $4000 additional for the detailed drawings and specifications, laying the assessments, etc. For $1000 additional they would attend the letting, and figure out the bids. This gave a total of $8000.

The City Council eventually awarded the work to a local surveyor at $350 for the preliminary work, and $1200 for the rest of the work, if the project is carried out. The Council seems to have thought that the best engineer is the one who asks the least for his work. It is interesting to note that in this case the payment for specifications and (alleged) expert service on engineering work which it is believed will cost nearly half a million dollars will be about 0.3% of the cost.

Chinese Engineers for Chinese Railways

Inquiries frequently come to us concerning the opportunities for engineers on railway construction in China. It was for years supposed that when China was once opened to railway construction, many opportunities of profitable employment would occur there for European and American engineers. Those of our readers who are at all familiar with Eastern affairs, however, know that China has followed the example of Japan; and in carrying out the works of Western civilization which it is so rapidly adopting, it is as far as possible putting the work in charge of Chinese engineers, many of whom have been educated in the best schools of Europe and the United States.

The Far Eastern Review for November contains an account of the work of Chinese engineers in the construction of the Kalgan Ry. and its extension to Kweihau-Chang. The chief engineer of the Kalgan Ry. was Jeme Tien-Yu, who graduated in civil engineering from Sheffield Scientific School of Yale University many years ago and had a long practical experience on railway work on the Peking-Mukden Ry. under C. W. Kinder. The article in the *Far Eastern Review* states that while the foreign-built Chinese railways running through open country have averaged a construction cost of $50,000 per mile, the Kalgan line, on which there are over a mile of tunnels and many heavy rock cuts and high embank-

ments was built by Chinese engineers at a cost averaging $40,000 per mile. In explanation of this low cost of construction attained by the Chinese engineers, it is explained that the work was so planned by them as to hold down cost and contractors' profits to a minimum, the work being let direct to small contractors. Foreign engineers doing business in China, because of their ignorance of the language, were generally compelled to rely upon an interpreter in dealing with contractors and others, and our contemporary says:

> This highly important functionary, who receives an average salary of $40 Mexican silver per month, was able to take advantage of the conditions, and as a rule retired with a fortune after several months' engagement.

In constructing the Changshui extension of the Kalgan railway to Kweihau-Chang, the chief engineer was K. Y. Kwong, who also received his education in a foreign engineering school. His associate engineers had never been out of China, however, and had gained their experience solely on Chinese railways. Our contemporary summarizes the results of the work on this extension as follows:

> The average cost of earth work on the Shanghai-Nanking Ry. was 15 cents silver per cu.yd., and on the Canton-Kowloon line 33 cents per cu.yd., whereas the average cost per cubic yard on the Changshui extension has been about 6 cents per cu.yd., and the highest price for rock excavation was 25 cents per cu.yd. The average cost of concrete work was $6.25 silver per cu.yd. against a cost nearly twice as high in other parts of China.

If this account in the *Far Eastern Review* is authoritative, there would appear to be little chance for European or American engineers in China in competition with the native engineers. Accepting the well known definition of an engineer as a man who makes a dollar earn the most interest, these Chinese engineers would seem to be entitled to high rank.

The Improvement in the Bond Market

The most encouraging piece of news to the engineering profession that has appeared for a good while was the marked success last week of the sale of $51,000,000 New York State 4½% bonds. The two New York banking firms which secured the whole issue at a bid price of 106.7 sold them, it is stated, within two hours at an average price of 107¼. The substantial premium commanded for this issue and the large number of bidders who made offers for it, taken in connection with the activity which has prevailed in the bond market generally since the beginning of the year, all indicate that the great amount of engineering work which has been postponed because of financial conditions may in no long time be undertaken.

Other favorable financial indications are the lowering of the rate of interest at European money centers and a large increase in savings bank deposits, together with a noticeable improvement in that barometer of industry, the steel trade. All these conditions have bred a spirit of hopefulness in business circles which is itself an important element in the restoration of that measure of general confidence in the business community without which any considerable measure of general prosperity is impossible. It is not likely that these conditions will produce a business boom, so called, in the year 1914, or at least not the sort of a business boom in which the promoter of all sorts of unsound enterprises finds a ready hearing. It does seem probable that cities and States and business concerns which are on a sound financial basis and which have legitimate use for capital to invest in engineering construction of various kinds are going to be able to obtain it on reasonable terms.

The Weight of Future Railway Rolling Stock

On another page of this issue we present a symposium, contributed to by the bridge engineers of a number of the principal railway companies, on the question whether it is wise at the present time to increase the current standards of strength for railway bridges in order to provide for future increase in rolling-stock weights. The general conclusions reached by these engineers are that the present heavy-weight bridges now being built are capable of carrying with safety so much heavier loads than they are designed for that it is not wise to make the larger investment required for a still further increase in strength.*

We believe these conclusions are sound, not only because of the structural considerations named but because it is by no means certain that the steady increase in rolling-stock weight, which has been going on ever since the railway era began, is to continue much further. We cannot always judge of the future from the past. Many a diagram has been plotted on which a line mounts steadily upward on an even grade, for a long distance, and then curves off to a dead level. Weights of railway cars and locomotives have been steadily increasing for fifty years past because there were strong reasons for such increase. Some of the conditions that brought about this increase and made it possible are being radically changed.

For one thing, there is general agreement among the experts in railway track that the stresses in railway rails produced by present rolling-stock weights, are, if anything, already in excess of the limit which reasonable requirements for safety would fix. Still heavier rail sections may help somewhat, but the experience with them has not been particularly promising. In fact, much of it has been disappointing. Rails of alloy steel are a possibility, and have even been tried to a limited extent; but the element of cost promptly enters in to shut off any considerable likelihood of progress in this direction.

It must be remembered that the whole problem is essentially an economic one. The weights of cars and locomotives have been steadily increased because this increase has meant a reduction in the cost of hauling a ton of freight over the road. We have reached the point, however, where terminal expenses, and not costs of road hauling, are the controlling figures in a large proportion of our freight traffic; and terminal expenses are increased, rather than lessened, where very long trains must be made up. Again, the saving in operating expenses by long trains is largely due to cutting down the costs of train crews' wages per ton hauled. But the "full-crew train" laws are already in many States a condition and not a theory. Again, we cannot go much beyond the present power of locomotives without either putting on

*A qualification made by several is that in case any radical increase in clearance limits should be made, it might then be necessary to face a further large increase in rolling-stock weights.

an extra fireman or adopting the locomotive stoker. On any considerable grades, doubleheading must be resorted to, or the use of pusher locomotives, with a resultant added cost and delay. The car wheel, as well as the rail, is also a limiting factor in further increase in rolling-stock loads.

From present indications, even if there should be a further increase of train weights, the locomotive capacity necessary to handle them would be obtained by stretching out the locomotive into a longer machine, making a Mallet compound of three units instead of two, for example, and this would not probably increase the load on bridges over that produced by present rolling stock. The engineers above referred to appear to be fully justified, therefore, in their conclusion that present heavy standards of bridge construction are likely to prove sufficient during a long period of years.

The Financial Responsibility of Directors

There is one industry which in 1914 appears likely to be extremely dull. In fact, there is reason to believe that this industry, which at certain times has reached enormous proportions, will hereafter be carried on in a very limited and desultory way. We refer to the industry of building branches and feeders and extensions and selling them at a large profit to existing railway lines.

We noted in our issue of Nov. 27, the revelations made in the Interstate Commerce investigation of the St. Louis & San Francisco R.R. receivership and the charge that the Chairman of the Board of Directors of the Frisco Co., B. F. Yoakum, and his associates made a profit of some $7,000,000 by building branch lines under various names and selling them to the Frisco Company.

On Jan. 26, the Commission submitted to the Senate an additional report, showing that the discounts and commissions to bankers and others on the sale of bonds and notes issued by the Frisco aggregated $30,665,749. At the same time while the company was selling bonds at heavy discounts and borrowing money on notes, it was continuing the payment of dividends, which it is now clear were not earned.

It is a well established legal principle that the director of a corporation holds a relation of trust to its stockholders; and if he uses this position of trust for his own profit, to the detriment of the stockholders, any stockholder has a right to bring a suit at law against the director to compel restitution. When a concern is placed in a receiver's hands, however, the entire property comes under the direction of the court and such a suit can only be brought with the court's consent.

Mr. W. W. Niles, of New York, a stockholder of the St. Louis & San Francisco Co., petitioned Judge Sanborn of the U. S. Circuit Court for permission to bring such restitution suits against former directors and officials of the company who were alleged to have profited by the transactions above referred to. Judge Sanborn denied this petition, but ordered instead that the Receivers of the company themselves should bring suit to compel such restitution. Further than this, Judge Sanborn displaced from the receivership officers who were identified with the former management, and made James W. Lusk, of St. Louis, an independent attorney, Chairman of the Receivers and ordered that Mr. Nile's attorneys should act as special counsel for the Receivers in the suits brought to compel restitution.

In accordance with this order, on Jan. 22, the Receivers filed a suit against B. F. Yoakum, Chairman of the Board of Directors, James Campbell, Vice-President, B. L. Winchell, former President, and seven others for the restitution of $14,409,000 paid by the Frisco Company for the St. Louis, Brownsville & Mexico R.R., together with the deficit of $1,309,000 which has accrued from its operation since the purchase.

This is the most businesslike proceeding that has been recorded in a very long time toward bringing about a better standard of honesty in the conduct of corporate affairs. It is necessary not merely to expose crimes in high finance, but to apply the proper corrective in order to teach the needed lesson. A suit for restitution strikes at the pocket nerve and will in some respects be more effectual in teaching the danger of dishonesty on a large scale than even a criminal indictment and trial.

It is of interest in this connection to record that Mr. Yoakum has issued a reply and explanation of the transactions exposed by the Interstate Commerce Commission's investigation. Concerning this explanation, our contemporary, the *Railway Age Gazette,* says:

> Mr. Yoakum's statement is not a defense; it is a confession. He is not a victim of a change in public opinion; he is suffering from the effects of having ignored public opinion, which long had frowned on the use of such business methods as he admits having used.

It is quite within the possibility that some stockholder of the New York, New Haven & Hartford or Boston & Maine railroads, hard hit by the present financial condition of these once prosperous companies, may appeal to the courts to compel restitution from those who profited in the transfer to these companies of a large assortment of railway and other properties by purchase, lease and otherwise, which are worth today, certainly, far less than the prices at which they were purchased or leased.

A very remarkable transaction which was not yet completed when the public overhauling of the New Haven situation occurred has recently been exposed to the public. The mechanism of that transaction may give a hint as to some of the reasons for the present financial condition of the New England railways. The transaction to which we refer is the construction of the Hampden R.R. in Massachusetts. According to official published statements given out a year or more ago, the Hampden R.R., about 14 miles in length, was built to furnish a physical connection between the New York, New Haven & Hartford and Boston & Maine systems in the vicinity of Springfield, Mass., so that through trains from New York by way of Springfield could be diverted at this point to the Boston & Maine tracks and run direct to Maine seacoast resorts or to the North Station in Boston.

This was the alleged reason for the construction and it is established that the construction was undertaken with the approval of President Mellen and his associates and with the understanding that the road was to be taken over on completion. But the question arises, why build a new railway here when there was a railway already existing? The Athol branch of the Boston & Albany R.R. parallels the Hampden R.R. for nearly its whole length. As the New Haven held a 50% controlling interest in the Boston & Albany, it was in position to at least make friendly negotiations for the use of this stretch of single

track for the few through-passenger trains that it might have been desired to operate in this way. Such an economical solution of the problem appears not to have been even thought of. Instead, a company was incorporated to build the new line under the name of "the Hampden Railroad Co."

The Public Service Commission of Massachusetts has recently had the whole transaction under investigation through the request of this company to the Commission to approve a bond issue of two and a half million dollars, which is in addition to the capital stock of $1,400,000 already issued with the Commission's approval.

It may be inferred from this that the Hampden R.R. is not a cheap road. The commission in its report says:

> The single fact that such a road, with no terminals and no rolling stock, is alleged to have cost about $290,000 a mile is enough to put the Commission on strict and careful inquiry as to the history of the enterprise and methods pursued in its construction.

Bearing this fact in mind, it is next of interest to notice that in order to construct this railroad the Hampden Railroad Co. let a contract to the Woronoco Construction Co. The Commission in its report says:

> Mr. Gillett, President of the Hampden R.R., stated that he was the Woronoco Construction Co. It seems that he might have stated with almost equal accuracy that he was the Hampden R.R. Co., as the eminently respectable gentlemen who were associated with him in the directorate of that railroad were apparently little more than lay figures.

It further appears, according to the Commission's report, that the Boston & Maine R.R. Co. had full knowledge of this situation and that the plans for the road were approved by Mr. Mellen, President of the New Haven. It may be thought that the high cost of the road might be due to its being a double-track line of phenomenally heavy construction. It appears, however, that the line is only single track; and where the sum of $290,000 a mile could have been honestly expended on its construction, is a problem which would seem worthy of some fuller and further inquiry.

Apparently, the Public Service Commission of Massachusetts holds this opinion also, for instead of approving the entire bond issue of two and one-half million dollars asked for, it approved an issue of only one and one-half millions. Reading between the lines, it appears to have made this decision on the theory that it would about reimburse the builder of the road and his bankers for their direct outlay, taking away only the million odd dollars or so of profit which they had expected to make.

In a dissenting opinion, Commissioner Anderson objected to this approval. He declared that the majority finding amounts to saying,

> the only penalty that will be visited upon you if caught is the loss of your profits. Such a ruling really puts a premium on fraud. When, as in this case, the money was spent for the benefit of the directors and not for the benefit of the corporation, there is no presumption that the cost bears any relation to the value.

A remarkable passage in the report of the majority of the Commission, in which it attempts to justify its action in approving the partial issue of bonds, is the following:

> There can be little doubt that the plan of building this railroad was honestly conceived in the belief that the undertaking would prove beneficial to the Boston & Maine R.R. Indeed the good faith of the project is almost conclusively established by the fact that it received the approval of the directors and stockholders of the Boston & Maine R.R., as well as the members of the Railroad Commission, without a dissenting voice. It will hardly be charged that the entire body of stockholders of the Boston & Maine R.R. were engaged in a conspiracy to defraud themselves and that the Board of Railroad Commissioners was a party to the conspiracy.

To anyone who knows the manner in which the affairs of a large railway or industrial corporation are actually conducted, it sounds like grim sarcasm to say that the stockholders of the Boston & Maine R.R. individually approved the construction of the Hampden R.R.

As everybody knows, including even the members of the Massachusetts Public Service Commission, practically the only power that a stockholder in a great corporation possesses is to fill out a proxy sanctioning the selection of such a board of directors as the management in control chooses to install in office.

Whatever legal effect a vote by a stockholders' meeting approving the purchase or lease of the Hampden R.R. may have had, we should like to see the Public Service Commission of Massachusetts try by oral argument to convince a stockholder of the Boston & Maine R.R. that he had any responsibility for the attempted unloading of this remarkable railroad onto the broken back of the Boston & Maine. In fact to many of the Boston & Maine stockholders it will appear that the Public Service Commission added insult to the injury they have already suffered.

Filtering Lake Water

That the water-supplies of all the cities on the Great Lakes should be purified is the leading conclusion of the four American and Canadian investigators who have just reported to the International Joint Commission on the boundary waters between the United States and Canada. The committee also concludes that the water-supply of some of the cities on the Great Lakes is so badly polluted with sewage as to make more of a burden than should be placed on water-purification plants. An abstract of the report on the extensive field work of these investigators appears elsewhere in this issue.

Offer of the New York Police Commissionership to Col. Goethals

The reports widely published at the close of last week that Col. George W. Goethals had accepted the Police Commissionership of New York City appear to have been based, we are glad to say, on no very sound foundation. It appears that Colonel Goethals very frankly stated the conditions under which he might accept such an appointment, which conditions, so far as can now be seen, are not likely to be realized.

The splendid reputation which Colonel Goethals has attained, reaching round the world, is valued by the whole engineering profession, for the success he has attained has been of the greatest service to the profession in raising it in public esteem. It would be a thousand pities to have an engineer holding such a unique position accept the risks inseparable from a position at the head of the New York Police Department.

It can hardly be doubted that Colonel Goethals will receive from the Nation at the close of his great work such recognition as would make still more evident the unwisdom of his transfer to the difficult work in New York City for which Mayor Mitchel has sought his aid.

Letters to the Editor

The Accident at the Pioneer Plant of the Utah Light & Railway Co.

Sir—I wish to comment upon the news note in your issue of Nov. 13, 1913, on the recent accident at the Pioneer station of the Utah Light & Ry. Co., in Ogden, and upon your editorial note in the same issue on "A Power House Designed as a House of Cards." I only wish that your paper could have waited instead of basing all that you state on the "conflicting and doubtful" reports "at present available."

I have thought it best to try to give you a correct account of this accident, particularly since we feel that just consideration should be given to the Pioneer engineers who designed some of the earliest hydraulic plants in the West. It must be remembered that this pipe line, something like six miles long instead of 6000 ft. as you state, and the power-plant building and machinery, etc., were designed and constructed in 1896, or 17 years ago. Considering the very difficult construction work (wood-stave for five miles and 6-ft. steel pipe for one mile) down through one of the roughest rock cañons in this country, I honestly feel that the original engineers deserve more credit than to have it said that the arrangements were designed as you imply. Never before in these long years has there been any trouble and the plant has always been very simple to operate and has run very reliably indeed.

We were installing two new 2000-kw. Francis wheel units together with a new controlling switchboard, to replace four old and inefficient units, and these were being put in final shape for operation. I am glad to state that the new units and switchboard equipment were not damaged in the least by the water and, in fact, the dust was not washed off the generators, nor off the new switchboard panels, nor the oil-switch and cable-barrier structure. Only the current and potential transformers and minor equipment in the basement, being soaked, required a few days carefully to dry and test out. Only one of the four old units was damaged so that it had to be rewound; the others, together with switchboard, were dried out to operate temporarily until the new units are completely ready for operation.

The disks on the new 24-in. valve were of cast iron and investigation to date seems to point to the fact that this material is not quite strong enough and the designers have furnished new steel disks. The flood would, of course, have been very much more serious had the branch penstock 54-in. valve not been nearly closed as well as the large 6-ft. valve at the head of the steel pipe which was all but closed by its own hydraulic piston.

The newspaper statement that "the station building filled with water which first escaped only at the upper windows and cornice openings some 45 ft. above ground, but later the lower openings burst open and let the water out," is absurd, as the water rose to no more than 2-ft. depth on the power-house floor. Also the statement that "several blocks in the immediate vicinity were flooded," certainly sounds bad, but the stream of water flowing into the tail race right at the plant did no damage and did not flood over several blocks. Only a small section of green brickwork underneath one of the windows near the new machines was knocked out and possibly 30 to 50 bricks loosened in another part of the building. The second 24-in. valve which you refer to does not exist, but there is a 54-in. valve back of the turbine intake which has to be closed by means of a set of hand-operated gears. This valve had been installed since the building of the plant and was not designed to operate under an unbalanced pressure, hence the trouble in closing it against stream flow.

Instead of the pipe collapsing at several points, only two or three small pieces of staves were pulled in at the upper end and the total cost of repairs to the pipe line did not exceed $100. Contrary to the statement that "the pipe line was not provided with vent openings, etc.," we put adequate vent openings on this pipe some time after its original construction to avoid danger of collapse.

Instead of outage to car traffic and lighting service in Ogden amounting to six hours, as reported, it was only a little over four until temporary connections were made across the house from incoming high-tension lines to the step-down transformers—to the distributing circuits. Instead of the damage amounting to from $50,000 to $100,000 as you state, it looks now as if the possible damage, cost of drying out, repairs to building, overhauling valves, etc., will not run over $5000 and will probably be very much less. I believe you will see therefore that the true story is very far from that indicated in your news-note heading, "A 13,500-hp. Hydro-Electric Plant Was Wrecked."

I would not, of course, want you to feel that we are criticizing your suggestions based on such accidents as this one and that at the Cazadero plant in Oregon, for they are certainly good and to the point. Perhaps it is not wrong to state that if some of us did not have an accident once in a while, engineers would not be as careful as they certainly need to be in working out the chain of details, that they may foresee and take care of any emergency which may come.

This accident brings out, besides possible inadequacy of design, one question that is everlastingly before us—that of the human element. The young helper who was attempting to show one of the other helpers, at shift-changing time, how to operate the new switchboard with the control mechanisms, etc., before the new machinery was turned over to the operating department, certainly did not know what he was doing, and your suggestion that "at least one of the other valves should have been closed even if a large section of the station had to be shut down" is certainly a good one in the light of the accident as it occurred. It only goes to prove the importance and the necessity of foreseeing all possibilities of accident from every source in everyday operation, as well as in the original laying out of a plant of any kind.

I hope you will receive this letter in the spirit in which it is written, as it was thought best to give the facts to offset some of the statements made—particularly since these have been given through a paper which is one of the most thorough in dealing with all of these matters of design and construction.

O. A. HONNOLD,
Electrical Engineer, Utah Light & Ry. Co.
Salt Lake City, Nov. 24, 1913.

[Mr. Honnold's letter was not intended for publication, but we give it space, with his consent, that justice may be done the designers of the old Pioneer plant and as an example of the fair and judicial attitude of an engineer in an irritating episode.

Perhaps we should state that, following our fixed policy of checking unauthentic reports, we telegraphed an independent engineer and the company for authentic details about this accident and, after much delay, got only very general statements of fact from either, while these gave apparent confirmation of published reports. Had the power company coöperated more, we could have eliminated the exaggerated figures of damage done and corrected the mistakes in details of apparatus.

It is now evident that the designers of the original Pioneer equipment were not at fault. Evidently the new equipment greatly concentrated the control of power apparatus, but without every needed safeguard against mishandling. It was, on a smaller scale, seemingly somewhat like the Panama Canal lock-control switchboards, stripped of their many interlocks.

No word of all our comment on this case has been intended as criticism of any designer or official; our aim has been only to convert "hindsight" in this case into "foresight" for other cases.—ED.]

The Use of Models in Engineering Design

Sir—I read with much interest Wm. M. Torrance's letter on the danger attending the use of models in engineering practice; and, although I have known from the time I studied the mechanics of materials that there is a variation in stress with increase or decrease in size, the rapidity of increase was never before so forcibly pointed out.

Mr. Torrance shows clearly the reason why stress varies in vertical structures such as tanks. A much simpler vertical structure—a plain cylindrical column, or a structure such as the Washington Monument—could have been used more easily and perhaps just as forcefully, for even a child can be made to perceive that the pressure on the foundation of a monument $^1/_{100}$ as high as the Washington Monument, and made of the same material, would be only about $^1/_{100}$ as much per square foot.

Little, if anything, was said about horizontal structures, so, to satisfy my own curiosity along this line I applied the old formula $M = \frac{fI}{y}$ to some horizontal cantilever beams of homologous proportions. I used the ratio of ten throughout as follows: My first cantilever beam was 10 in. long, by 1 in. wide, by 1 in. deep; my second beam was 100x10x10 in.; and my third, 1000x 100x100 in. I assumed these beams to be made of solid cast iron and computed the extreme fiber stress in each case due to the weight of the beam alone, with no external forces acting. Although I used the weight for cast iron throughout, I did not make computations for the neutral axis as some computers perhaps would have done with cast iron. I assumed that the neutral axis lay exactly midway between the top surface and bottom surface of every beam. For results, the extreme fiber stress in the smallest beam would be 78 lb. per sq.in.; in the next larger size, 780 lb. per sq.in.; and in the largest size, 7800 lb. per sq.in. This, therefore, fulfills Mr. Torrance's contentions.

It is evident that this point should be given a little more prominence in our engineering schools. I know of several cases where technical graduates in responsible positions, who didn't like the appearance and proportions of drawings, made changes with the eye without making further calculations. I have done the same thing myself unwittingly, because I did not fully realize the seriousness of the relation between large and small scales. In every case, however, as far as I can recall, material was added and the alteration was on the side of safety. Further, as all of my designs were mechanical, not structural, the "eye alteration" was not serious as it would have been in the case of a bridge design.

I recently witnessed an example in this connection, where a boiler accessory was being "designed." Stresses were not computed at all; an artist was employed to "draw a picture" of the part on the photograph of a boiler, reduced at least 20 times. The artist's work was supervised by a man who doubtless had never computed a stress in his life. The accessory was actually built and proportioned from the painting, is on the market today, and is a success. It is amply strong and, besides, it "looks good."

W. F. SCHAPHORST.
503 W. 148th St., New York City.
Jan. 3, 1914.

Sir—In your issue of Dec. 18, Wm. M. Torrance calls attention to an important governing principle to which too little attention has been given by writers on applied mechanics and by engineers. "Practical men" and others may easily deceive themselves in "The Use of Models in Engineering Design."

Professor Slocum, in his recent book on the theory and practice of mechanics (Henry Holt & Co., 1913) gives a brief discussion in five pages on "The Theory of Models," wherein he sets forth the relations which obtain both under statical and dynamical conditions. But long ago the elder Trautwine in his "Pocket Book" (edition of 1876, p. 220) gave a clear exposition of the principle in half a page; and every similar manual should include such an article to warn the readers against misconception on this subject.

In the days referred to, the writer had a class construct a model of a wooden (except for the diagonals) Pratt truss railway bridge on a scale of one-twelfth, span of 84 ft. represented. This weighed 32 lb. and, in order to put the model under stress in all of its members *proportionate to the scale* and due to weight of structure relative to the full-sized bridge, it was necessary to load it with a weight of 350 lb. uniformly distributed—about the weight of two moderately heavy men. The actual bridge would have weighed 1728 ($= 12^3$) $\times$ W (weight

of model); while the cross-sections of members would carry 144 (= 12^2) W; whence (1728 ÷ 144) $W - W$ = 11 W, *additional* weight; and 32 × 11 = 352 lb. The *weights* of similar structures must vary always as their volumes, or cube of the scale ratio; while their *strengths* must vary as the *cross-sections* (approximately) of their homologous parts, which are to each other as the square of the scale-ratio. The model was tested to destruction and failed under the proper load; about 7000 lb., according to the "factor of safety" then used.

The second bridge to span the Connecticut River—the first being at Bellows Falls—was built at Hanover, N. H.; for which, according to probably trustworthy tradition, the designer first made a model which was quite effective in winning supporters for the enterprise. The bridge was of the arch type (details now unknown), 236-ft. span with rise of 20 ft., for which the main timbers, hewn from primeval pines were 60 ft. long and 18 in. square. President Dwight of Yale wrote admiringly (1797) of this bridge in his *Travels* (Vol. II, p. 117). But it *fell by its own weight* after a short life of eight years (1796 to 1804). If the model had been loaded enough to strain its members proportionately to the effect of the dead weight of the actual bridge, they might have learned enough to avoid the catastrophe.

The preceding cases had to do mainly with statical conditions, but the following instance, involving dynamical effects, is still more to the point: Before the elevated railway was built in Boston the late Capt. J. V. Meigs made strenuous efforts to have his single-truss elevated railway adopted. The track or "way" or truss was provided with two bearing rails for the horizontal wheels and two lower rails for the diagonal wheels of a unique form of truck, and the truss was supported on a single line of columns, as in the first New York elevated railway. This is fully described in Vol. VII, *Transactions*, Am. Soc. M. E., paper No. 189. An expensive working model was set up in a large upper room of a warehouse in East Cambridge, Mass., where the inventor demonstrated the "successful working" of his scheme to visitors, as he did to the writer and a class of students in November, 1885.

The model engine weighed 275 lb., the tender 80 lb., with a model car six feet long. Steam was "gotten up" quickly and the train developed an average speed of 10½ ft. per second, passing curves of 6¼-ft. radius and mounting grades equivalent to 610 ft. per mile (adhesion increased by accumulator pressure on the horizontal truck wheels). On level track a speed of 22 ft. per sec. was made.

This performance doubtless convinced the most skeptical; but on this occasion the spectators were reminded that the forces in action, especially the centrifugal reaction on the curves, would be vastly out of proportion to the scale, in the full-sized train. The model was made on a one-eighth scale, and, if W represents the weight and v the velocity of the model, this centrifugal reaction would be expressed by $\frac{W}{g} \times \frac{v^2}{r}$. Assuming a velocity in the same proportion, one-eighth of, say, 66 ft. per sec. (45 mi. per hr.) = 8¼ ft. per sec., and radius r of curve in like ratio, then, since W of the large engine will be as the cube of the scale, we have the action of the actual engine measured by $\frac{(8)^3 W}{g} \times \frac{(8)^2 v^2}{8 r} = 4096 \frac{W}{g} \times \frac{v^2}{r}$. To resist this the strength of track, truss, trusses, columns, etc., which depends upon the cross-sections, would be in the ratio of $(8)^2 = 64$ to 1; so the disproportionate dynamic effect of the full-sized engine would be 4096 ÷ 64 = 64 times greater than any which the model could possibly exert. The numerical measure of the larger effect would be, on a curve of 6¼ × 8 ft. radius: $4096 \times \frac{275}{32} \times \frac{8\frac{1}{4} \times 8\frac{1}{4}}{6\frac{1}{4}} = 384{,}000$ lb. This is 2.7 times the weight of the machine (275 × 8³ = 140,800 lb.); but it will be noticed that the radius is quite short and the speed (66 ft. per sec.) for so sharp a curve is not permissible. Right here is where the uninstructed experimenter is deceived if he infers proportionate dynamical stability from the beautiful behavior of the model.

A different case is that of an experimental model dam. In a discussion we usually consider only a unit of length, say 1 ft. Assume a model 2 ft. high with any acceptable cross-section, to represent by a one-ninth scale a proposed dam 18 ft. high. Here relative *statical* effects depend upon the hydrostatic law that the pressure varies as the square of the depth ($w \times h \times \frac{h}{2} = \frac{w h^2}{2}$: $w \times 9h \times \frac{9h}{2} = 81 \frac{w h^2}{2}$). But the similar cross-sections also vary as the square of the scale; and all pressures and resultants in the two cases hold the same relative position. Hence, this is a case where the full-sized dam really has stability proportionate to that of the model.

This condition, however, is far from true when overflow occurs. For instance, assume 6 in. gage depth of flow over the model, which would represent 54 in. over the proposed crest. Now the hydrodynamic law of discharge over weirs is (the quantity) $Q = c\,l\,h^{\frac{3}{2}}$, in which c is a constant, l the length and h the gage height above the crest; and $(9)^{\frac{3}{2}} = 27$. Here, then, the discharge over the full-sized dam would be 27 times that over the model; and, more than that, *it has nine times as far to fall* (really 9½, from the center of gravity of the overfall). The energy acquired, which measures its capacity for destruction, varies with the height of fall and is, therefore, 9 × 27 = 243 times that of the water discharged over the model dam.

Considering this inexorable mechanical law the designer may anticipate in some degree the tremendous impact against the backwater below, the scour on the bed of the channel, the "kick-back" or reaction against the apron and toe of the dam, the vacuum effect upon the dam itself, etc.; but these would not be even faintly suggested by the behavior of the model and its 6-in. overflow. Evidently, it is the kinetic energy of the falling water which produces the greater effect in this case; while in case of the engine on the curved track, the mere *pressure* against the rail *does no work*, radially, so long as the rigid support opposes equal and opposite resistance.

Finally, a static example illustrates one other point: Some years ago the writer caused to be built, a model group of four groined-concrete arches to represent, on a scale of one-fifth, proposed arches of 20-ft. span for covering filter beds. The model arches, therefore, had spans of 4 ft., while the thickness at the crown was one inch;

the rise was one-fifth of the span. It was not possible, of course, to distribute the compensating weight so as to produce the exact internal stress in the arch due to its own weight, but sufficient gravel was put on to secure an approximation. Howbeit, the *surcharge*, representing say 18-in. depth of earth over the entire structure, had to be of *the same even depth upon the model as upon the full-sized arches*, because the ratio of the two areas covered was 1 : 25, and thus the load on the model satisfied the rule of the inverse square of the scale ($1 \div 5^2$).

These examples are enough to put proper emphasis upon the importance of the principle so well presented by your correspondent.

ROBERT FLETCHER,
Director, Thayer School of Civil Engineering.
Dartmouth College, Dec. 29, 1913.

Sir—In ENGINEERING NEWS of Dec. 18, William M. Torrance calls attention to the fact that the sufficiency of a model to withstand the stresses upon it, does not justify the assumption that the actual and larger structure will safely sustain loads proportionate to its size.

Mr. Torrance arrives at the conclusion that "the model is stronger than the structure illustrated, in the exact inverse ratio of the scale to the model," and concludes "I do not know that there is anything new in the ideas suggested above."

I venture to quote as follows from the "Civil Engineer's Pocket Book" (Trautwine), p. 478:

Strengths and Weights of Similar Beams of Different Dimensions. Comparison between Models and Actual Structures.

48. In any given beam, let W_m = the load causing any given unit stress S. Then $W_m = \frac{n\,S\,b\,d^2}{L}$ (for n, see table, p. 474); and, in any similar beam, of a times the breadth, depth and span, the corresponding load $W = \frac{n\,S\,a\,b\,a^2\,d^2}{a\,L}$. Hence, the ratio of their loads is $\frac{W}{W_m} = a^3$; or $W = a^3\ W_m$; but the ratio of their weights is $\frac{w}{w_m} = \frac{ab\ ad\ aL}{b\,d\,L} = a^3$; or $w = a^3\ w_m$

49. In other words, comparing one beam with another, of a times its breadth, depth and span, their strengths are as the squares of their respective dimensions; but their weights are as the cubes of those dimensions.

50. Hence, if a model of a beam will just break under a uniform load (including its own weight w_m) equaling 2, 3 or 4, etc., times its own weight, then a beam of similar cross-section, but of 2, 3 or 4, etc., times its breadth, depth and span, will just break under its own weight alone.

In the first edition (1872) appeared a similar caution, beginning:

Art. 46. **Comparison between Models and Actual Structures.** Many practical men imagine that if a model is strong, an actual bridge, roof, etc., constructed with precisely the same proportions, must be equally strong in proportion to its size. This arises from their ignorance of the fact that the strength of similar beams, trusses, etc., increases only in proportion to the squares of their spans, while their weight increases as the cubes of the spans.

JOHN C. TRAUTWINE, JR.
257 S. 4th St., Philadelphia, Penn.,
Dec. 24, 1913.

[Proportionality of load capacity to size depends not only on the stress variations noted by our correspondents, but also on unit strength, which in some materials, notably concrete and wood, varies exceedingly with size. —ED.]

False Economy to Dispense with a City Engineer

Sir—I wish to take issue with an opinion which your modesty leads you to express in your issue of Jan. 8, 1914, in regard to the dismissal of the city engineer of Birmingham, Ala. You remark: "It is not for us to say that it [the city] is not acting wisely" in dispensing with the services of the city engineer "but this is . . . an extreme of economy."

I wish to combat the idea, so extremely harmful to the engineering profession, that this is economy at all and to dissent from the view that it is not within your sphere to criticize such false ideas of economy. I believe strongly in economy. I am not arguing for the retention by the engineer of his salary but for the retention by the city of something very valuable—seasoned engineering judgment. This value is not apparent to the average man. He is likely to look on engineering as surveying, as driving stakes and think it can be done as well by the assistant city engineer or by the transitman and at less salary and therefore cheaper. If economy is necessary, and it is, and saving money is right at such times as the present, let retrenchment take the form of using fewer assistants, reducing the chief engineer's pay, cutting out so much expensive construction (mainly there) and reducing vastly the scope of the municipality's activities.

C. E.

Nashville, Tenn., Jan. 17, 1914.

Facts of the Grade-Crossing Accident at Memphis, Tenn.

Sir—Your report, under heading of "News Notes," in ENGINEERING NEWS, of Jan. 15, p. 149, of the fatal grade-crossing accident in Memphis, on Jan. 4, is not entirely in accordance with the facts.

The accident occurred at the intersection of Lamar Boulevard, the Nashville, Chattanooga & St. Louis Ry. and the Union Ry. Co.'s tracks, in the outskirts of Memphis. The street car was struck by a Union Ry. freight train, while making a "back up" movement, killing five out of the nine occupants of the street car, and injuring two.

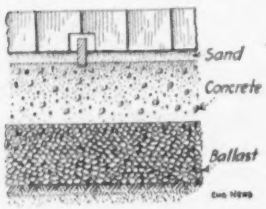
The tracks of the two railroad companies named are separated by a space of about 65 ft. At the coroner's inquest it developed that the conductor of the street car "flagged" this car across the tracks of the Nashville, Chattanooga & St. Louis Ry. but failed to protect it against the tracks of the Union Ry. Co. It was also brought out that the motorman was talking to two women in the front vestibule, and failed to notice the stop signals made by the foreman in charge of the switching crew.

The Nashville, Chattanooga & St. Louis Ry. had nothing to do with the accident, and the removal of its outbound main tracks, by the Mayor, was only temporary. The track was reëstablished.

W. F. SCHULZ,
Chief Engineer, Board of Control Subway Construction.
681 Rayburn Boulevard, Memphis, Tenn.,
Jan. 19, 1914.

A Wood-Block-Pavement Failure

Sir—The accounts in recent issues of ENGINEERING NEWS of failures of wood-block pavement have interested many and have shown wherein weaknesses are apt to occur. During the past summer the writer witnessed the laying of some wood-block pavement in Rock Island, Ill., on 3rd Ave. The failure, as described below, took place during a wet spell and not over a month subsequent to the completion of the work. The paving was for a street with a double-track street-car line and wood blocks were used between the rails and between the two tracks. The foundation consisted of about 6 in. of crushed-rock ballast, 5 in. of 1:2:4 concrete and 1 in. of sand. The top surface of the pavement was finished by mopping with hot pitch. Steel bars were used to space the rails as is common practice, and were about 15 or 20 ft. c. to c. As the blocks did not clear the tie-bars, blocks ship-lapped on one edge were used at the tie-bars.



The paving failed by bulging up between the rails only, and not between the tracks where there were no tie-bars and at distances apart that were substantially the same as the tie-spacing. The conditions at a point of failure on this street are shown in the accompanying sketch. The point I wish to make is that the failure of the pavement was due to the use of the ship-lapped blocks, as they were unable to resist the stresses caused by the swelling of the wood, without causing eccentric stresses sufficient to bulge the blocks. In other words, the use of blocks with ship-lapped edges invites failure. Would it not have been better to have left open the space of about ½ in. over the bars and filled it with hot pitch or asphalt, thus doing away with the need of the ship-lapped edges?

RODNEY C. DAVIS.

Rock Island Lines, La Salle St. Station,
Chicago, Ill., Dec. 27, 1913.

Fraternity or Unionism for Engineering Draftsmen

Sir—Recently there was handed to me an advertisement of the New Jersey Civil Service Examinations; the first three appointments mentioned were Mechanical Engineer, $1200; Architectural Draftsman, $900; and Doorman for Police Department, $1200. As most of your readers have spent several years and many hundreds of dollars studying engineering, it will be needless to make any comment on this tribute to the profession.

About the same time I read with much interest a letter in ENGINEERING NEWS, from Louis A. Heyn, Recording Secretary of the Chicago Technical League, announcing the formation of that Association, in affiliation with the American Federation of Labor, for the purpose of advancing engineers' salaries and standardizing positions.

This looks like the handwriting on the wall again.

The American Society of Engineer Draftsmen is by no means the first organization started with a view to get draftsmen together into a fraternal, educational and protective association, by adopting other than union methods; and the Chicago Technical League is not the first attempt to unionize draftsmen or engineers. The American Society of Engineer Draftsmen has, however, made progress and rapid progress where attempts to unionize draftsmen have been, so far as we know, local, and have mostly suffered the fate of having their leaders "fired" and the movement quashed. If, however, the American Federation of Labor has decided that the time has arrived for *it* to unionize draftsmen, and if it has now decided to start operations in Chicago, then this is a very different matter.

It is not our purpose to knock any society or any form of organization. What we want to do is to get men to think. It seems to be generally accepted today that there is need for some organization of a fraternal nature in the engineering field; the only question being whether it should be run on union lines, demanding established wages and hours and using the strike as a means of enforcing its demands, or whether it should exert its energies in the direction of assisting its members to become most highly efficient, leaving the question of remuneration to be decided by the individual.

Many persons consider that unionism in standardizing wages would reduce (pray forget about the New Jersey Civil Service) professional men such as engineers and draftsmen to the level of laborers. Nevertheless, we would hate to think that there is an architectural draftsman to be found in New Jersey who would not willingly lose that trifle of $300 per annum rather than suffer the loss of dignity in belonging to an association of his fellows which might prevail on the Civil Service, and other services, to the end that he might be found to be worth as much as an unskilled laborer!

to the handwriting on the wall, viz., the rapidity with

The purpose of this letter is: first, to draw attention which the realization of the necessity of collective action for material benefit is taking hold of the technical man, as evidenced by the surprising growth of the American Society of Engineer Draftsmen, which is now a firmly established organization; and the fact that the American Federation of Labor appears to have taken the matter of organizing technical men in hand also; second, with the kind permission of ENGINEERING NEWS, to invite those who are most concerned—the engineer and the draftsman—and who believe in fraternal organization to state their views on the subject.

There are many technical men who realize the advantage of organization, but who are too indifferent to take any action until some circumstance compels them to do so. There are a great many, especially designers, who are opposed to the principle of standardizing grades and wages, and who argue that while it may be possible to standardize physical labor it is not possible to do the same with mental effort; and that any action in that direction would affect them adversely. They hold aloof from fraternal organizations and are too absorbed in their own egotism or too dull to understand that they cannot afford to treat the matter with indifference.

If an organization of the smaller fry, backed by the great American Labor Movement, takes the matter seriously in hand, the standards they object to will be established without any reference to them, and—if their views are correct—their material standing will be re-

duced, thanks to their own sluggishness, at a time when action might have guided the rising stream into a safer channel.

WALTER M. SMYTH,
Sec'y American Society of Engineer Draftsmen.
74 Cortlandt St., New York City, Jan. 6, 1914.

Volume of a Perch

Sir—We have received a letter, relative to the volume of a perch, in which reference is made to our letter published in ENGINEERING NEWS, of Jan. 26, 1905; and we find upon looking up further information on the subject that there is an error in the information given for the State of Delaware. The volume of a perch of stone when measured in cars should be 31½ cu.ft., instead of 30½ cu.ft. as we stated in 1905.

In this connection it might be of interest to you to have the additional information that the volume of a perch in Iowa and Nevada is 25 cu.ft., and in Idaho 16½ cu.ft.

S. W. STRATTON.
Director, Bureau of Standards, Washington, D. C., Jan. 12, 1914.

[The letter referred to by our correspondent, published Jan. 26, 1905, p. 98, defines the volume of a perch in the states of Oklahoma, North Dakota, South Dakota, Ohio, Delaware and Colorado.—ED.]

NOTES AND QUERIES

V. W. R., Cody, Wyo., inquires as to the maximum depth at which divers are able to perform efficient work, and a source of information on the subject. We quote the following from the American "Civil Engineer's Pocket Book"

The nominal maximum depth for a diver is 100 ft., the ordinary maximum for a strong and expert diver is 150 ft., and the maximum ever reached is 202 ft. Strong and experienced divers can stay under water 2 hours at 100 ft., and 5 or 6 hours at 90 ft., but the maximum depth at which a diver can do any considerable work is 60 to 80 ft.

The contract held by the O'Rourke Engineering Construction Co. for the high-level bridge piers over the Cuyahoga River at Cleveland, Ohio, has not been canceled as was reported in recent Cleveland newspapers, and noted on p. 45 of our Construction News Section, Jan. 22 issue. The contract for the two piers was awarded to the O'Rourke Co., on Nov. 1, 1912, and the first pier was completed last May. Work on the second pier could not be begun because the city had not obtained the right-of-way for its construction. This was secured in December and the work of construction will go forward as rapidly as the weather permits dredging operations to be carried on.

Acoustic Effect of Fireproofed Cotton-Flannel Sound Absorbers*

BY F. R. WATSON†

Cotton-flannel was found to be a fairly good absorber of sound, during a recent investigation of the acoustic properties of the Auditorium at the University of Illinois. It is easy to obtain and to install; it is also comparatively cheap; but, unfortunately, it is inflammable. The question then arose as to the effect of fireproofing upon the sound-absorbing qualities of cotton-flannel.

A search through the literature on the subject did not yield very much, and apparently little has been done on this particular phase of the problem. In 1902, Norton[1] published an account of some experimental tests of the sound-absorbing qualities of materials that were already fireproof. Sabine[2] describes some experiments in which hair felt was covered by burlap attached by silicate of soda. In neither of these investigations was it apparent just what effect the process of fireproofing had. The author then took up the problem of testing flannel before and after fireproofing.

The observations were taken by Sabine's method.[3] In a room, about 20x20 ft., cleared of all furniture, an organ pipe was sounded for several seconds and then stopped. The time taken for the sound to die out was noted by an observer who made the record electrically on a chronograph drum. This observation was repeated at least ten times. A similar set of measurements was then taken when a large sheet of outing flannel was hung in front of one of the walls. A third set was taken with a sheet of fireproofed cotton-flannel in place of the unfireproofed.

A summary of results follows; each record is the average of at least ten measurements.

Date	Empty room sec.	Cotton-flannel Unfireproofed sec.	Cotton-flannel Fireproofed sec.
June 26	3.3	2.3	2.4
		2.4	2.3
June 30	3.2	2.2	2.3
	3.3	2.1	2.2
Average	3.26	2.25	2.30

The results indicate that the fireproofing, for the conditions of the experiment, did not materially change the sound-absorbing properties of the cotton-flannel. This result was rather surprising since it was expected that the fireproofed material would be the poorer absorber of sound. The two samples used were cut from the same piece of goods. The unfireproofed piece was fluffy and rather thick, while the other piece in process of fireproofing was soaked in a solution, then squeezed flat by being run through a wringer, and finally dried.

It seemed likely that the fireproofed piece would absorb sound less readily, since it was now squeezed into a closer texture and its interstices apparently more or less filled with the fireproofing substance. The experiments, however, showed it to have the same effect as the unfireproofed. Each sample was hung about four inches from a plastered wall, and pleated in folds so that each width of the flannel (30 in.) covered only a foot. The total area of each piece when in place for the experiment was about 9x12 sq.ft. The flannel cost about 15c. per yard, including fireproofing.

Sewerage Studies for the City of Los Angeles, Calif., now being made under the direction of Homer Hamlin, city engineer, will probably lead to comprehensive plans for territory which is likely to be annexed to the city within a few years. No large trunk sewer construction is contemplated for the immediate future, but the rapid growth of the city and vicinity makes it necessary to plan for additional main sewers to the ocean.

*The permanent fireproofing of fabrics was briefly described in a news note in "Engineering News," of Oct. 10, 1912.—Ed.

†Assistant Professor of Physics, University of Illinois, Urbana, Ill.

[1] C. L. Norton, "Soundproof Partitions," "Insurance Engineering," Vol. 4, p. 180, 1902.

[2] W. C. Sabine, "Architectural Acoustics," "Architectural Quarterly," of Harvard University, March, 1912.

[3] W. C. Sabine, "Architectural Acoustics," "American Architect," 1900.

American Society of Civil Engineers' Annual Meeting

The reports of the Board of Direction, the Secretary and the Treasurer at the annual meeting held in New York City, Jan. 21, showed that the American Society of Civil Engineers has now reached a stage of prosperity, little expected and probably hardly hoped for by its founders, or even its members of 25 years ago. The total membership on Jan. 1, 1914, was 7272, an increase of nearly 500 within the past year.

The mortgage debt on the Society house was reduced during the year $35,000—from $115,000 to $80,000—and the reserve fund invested in New York City bonds now consists of $80,000; so that the Society for the first time is practically free from debt, with an income of over $150,000 a year and current expenses of about $120,000 a year.

Those in attendance at the business session on Wednesday morning filled the auditorium of the Society's house to overflowing.

The most interesting development of the meeting was the triumph of the members who favor certain changes in the Society's organization over the older members who oppose the changes. The struggle came on the report of the committee on proposed amendments to the constitution, which was composed of Mordecai T. Endicott, Chairman, John A. Ockerson, Frederic P. Stearns and Allen Hazen.

Proposed Amendments to the Constitution—The first amendment reported upon by the committee was proposed nearly a year ago by five members of the Society and relates to the nomination and election of officers. This amendment provides for the redistributing of the membership into 13 geographical districts instead of 7 as at present, but the number of members of the nominating committee will remain the same. Under the present scheme each district is entitled to two members on the nominating committee, who hold office for two years, one member from each district being appointed at each annual meeting, unless there are additional vacancies caused by death or other reasons. Under the proposed scheme only seven members, as at present, will be appointed at the annual meeting, each to serve two years; one of these will come each year from the New York City district, while the other districts will have a member only every other year. Hence, while there are more districts, the real status of membership of the nominating committee is practically unchanged.

At the business meeting held at the annual convention in Ottawa last June, approval was given to the first part of the amendment for increasing the number of districts. There was then a lengthy and confused discussion on the remaining part of the amendment, and the whole was finally referred to a committee appointed at that time. This committee construed the vote of last summer's convention as a "quasi-approval of the amendment in its entirety," and therefore suggested no amendment to the amendment and recommended that it be sent out to letter ballot without change.

The second group of amendments which were proposed about a year ago by over 100 members, headed by O. E. Hovey, of New York, affects the status of the Secretary, and the manner of selection of the nominating committee. The object of the first of these changes is to make the Secretary no longer a member of the Board of Direction, and to have his salary fixed by a letter-ballot vote of the entire Board, instead of by vote of those who may be present at a business meeting. The second of these amendments takes the election of the members of the nominating committee from the several districts out of the hands of the Board of Direction and of the annual meeting and places it entirely in the hands of the members resident in each district.

The committee to which all of the proposed amendments was referred reported that they should be sent to letter ballot, and a struggle was at once begun to prevent this action. The opposition was led by John F. Wallace, who argued that the Society was too prosperous to hazard such a radical change, and that time had not been given for a sufficient discussion, etc.; he, therefore, made a motion to refer the report back to the committee for further study. Members of the committee, Messrs. Endicott, Ockerson and Hazen, objected, Mr. Hazen stating that it was useless to refer the report back to the committee which had already amended the proposed amendments so far as was consistent with their perfectly evident intent. It was then proposed to lay the report on the table. Other conflicting motions were made and a parliamentary tangle seemed inevitable when President Swain ruled that the annual meeting could do nothing in regard to the report, and that the amendments must now go out to letter ballot of the members in spite of any objections from the floor, according to his interpretation of the constitution [Article IX, Sec. 4]. The President's ruling was challenged, put to vote and sustained by a large majority.

C. S. Churchill (Roanoke, Va.) then made a motion that the meeting adopt a resolution declaring the proposed amendments undesirable. This was objected to by several members, among them H. B. Seaman (New York City), who protested that any such vote would be taken by the thousands of members not in attendance as an attempt to prevent them from deciding the question for themselves. The motion was lost by a vote of 102 to 90. Waldo Smith (New York City) made one final effort to save the day for the conservatives by proposing that a copy of a previous protest (signed by 762 members and submitted simultaneously with the proposed amendments at the Ottawa meeting) be mailed to the membership along with the blank ballots for a vote on the amendments. Mr. Hovey and others spoke against this motion and it was lost by a large majority. The amendments accordingly go to the members for letter ballot as reported.

Committee Reports—A progress report of the special committee to formulate principles and methods for the valuation of railway property and other public utilities (an 80-page pamphlet) was distributed in printed form. It was referred back to the committee without discussion for further study. It was determined that the committee should set a date for written and oral discussion of the report, and it was decided not to print it in the *Proceedings* until it was in final form.

The report of the committee on bituminous materials for road construction was read and accepted; an abstract appears elsewhere in this issue. The special committee on compensation of civil engineers reported, but the report (printed in our issue of last week) was referred back to the committee for further study, without any discussion from the floor. Prof. Dugald C. Jackson, the dissenting member of the committee, stated that he considered the report altogether too optimistic as regards the average compensation, and that the minimum compensation was so very low that it required investigation.

The committee on column tests submitted no report and asked for a continuation of its work. The concrete committee reported progress, but no final report. The committee on engineering education, Desmond Fitzgerald, chairman, reported that the committee had spent two years trying to obtain the Carnegie Foundation's cooperation to make a detail investigation of engineering education. The Foundation had within the last few weeks notified the committee it was about to take up this work. The Foundation is to pay all the expenses and the work is to be done by the Foundation's employees in consultation with the committees of the various national engineering societies.

The Secretary read a communication from Augustus Smith (Bayonne, N. J.), in which the writer suggested the forming of a judiciary committee of the American Society of Civil Engineers, composed of some 50 members, to be formed into boards of arbitration for the settlement of disputes between both members and non-members of the Society. The Board of Direction had considered the suggestion, the Secretary said, and recommended arbitration for the settlement of disputes, but considered a Board of Arbitration of the American Society of Civil Engineers impracticable at the present time.

Chas. H. Higgins (Jersey City, N. J.) offered a resolution that the Society favors legislation to regulate the practice of civil engineering The motion was laid on the table without discussion.

A New Committee on Stresses in Railway Track—A committee was appointed to act jointly with a similar committee of the American Railway Engineering Association to investigate stresses in railway track. Members of this committee appointed by the President were A. N. Talbot, University of Illinois, Chairman; A. S. Baldwin, Chief Engineer, of the Illinois Central R.R.; J. B. Berry, Chief Engineer of the Chicago, Rock Island & Pacific Ry.; G. H. Bremner, Engineer of the Illinois District of the Chicago, Burlington & Quincy R.R.; John Brunner, Assistant Inspecting Engineer, Illinois Steel Co.; W. J. Burton, Designing Engineer, Missouri Pacific Ry.; C. S. Churchill, Chief Engineer, Norfolk & Western Ry.; W. C. Cushing, Chief Engineer of Maintenance-of-Way, Southwest System, Pennsylvania Lines; E. Gerber, Assistant to the President of the American Bridge Co.; R. W. Hunt, Chicago, Ill.; G. W. Kittredge, Chief Engineer, New York Central Lines; William McNab, Principal Assistant Engineer, Grand Trunk Ry.; G. J. Ray, Chief Engineer, Delaware, Lackawanna & Western R.R.; F. E. Turneaure, University of Wisconsin; and J. E. Willoughby, Chief Engineer of the National Rys. of Haiti.

Award of Prizes—The Norman Medal was awarded to J. V. Davies (Jacobs & Davies, New York City) for his paper on "Air Resistances to Trains in Tube Tunnels." The Thomas Fitch Rowland Prize was awarded to Burgis G. Coy for his paper on the Laramie-Poudre Tunnel. The new James R. Croes Medal was awarded to B. F. Cresson, Jr. (former Deputy Commissioner of Docks and Ferries, of New York City), for his paper on "The Problem of the Lower West Side Manhattan Waterfront of the Port of New York," and the new James Laurie Prize went to M. M. O'Shaughnessy, of San Francisco, for the paper, "The Construction of the Morena Rock-Fill Dam, San Diego County, Calif."

Election of Officers—Officers elected for the ensuing year are: President, Hunter McDonald, Chief Engineer of the Nashville, Chattanooga & St. Louis Ry., Nashville, Tenn.; Vice-Presidents, Charles F. Loweth, Consulting Engineer of the Chicago, Milwaukee & St. Paul Ry., Chicago, Ill., and Gardner S. Williams, Consulting Engineer, Ann Arbor, Mich.; Treasurer, John F. Wallace, Consulting Engineer, New York City; members of the Board of Direction, Geo. W. Fuller and Arthur S. Tuttle, District 1; Charles H. Keefer, District 2; Mortimer E. Cooley and Eugene E. Haskell, District 3; Richard Montfort, District 5. Members of the nominating committee were appointed as follows: Louis P. Rights, Joseph R. Worcester, Frederick E. Turneaure, Thomas Earle, John W. Woermann, Thos. U. Taylor and Milo S. Ketchum.

Road Construction and Maintenance

Engineering Organization for Highway Work—Willis Whited, bridge engineer, State Highway Department of Pennsylvania, opened the discussion on state highway engineering organization by outlining the Pennsylvania scheme. Following the reading of this paper, President McDonald surrendered the chair to W. W. Crosby, Baltimore, Md., who acted as chairman throughout the remaining sessions.

An ideal municipal highway department was described by Wm. H. Connell, chief of the Bureau of Highways and Street Cleaning, Philadelphia, Penn. Mr. Connell thought that street cleaning should be under the control of the highway department and that this branch of city work should receive more engineering supervision; included in street cleaning were also the collection and removal of garbage and rubbish. It was suggested that the patrol system of street inspection could be performed by the men in charge of street cleaning. Figures quoted on the sums of money spent during the last few years by a few of the largest city highway departments made the cost of the Catskill Aqueduct and the New York Barge Canal seem insignificant.

Chas. J. Bennett, state highway commissioner of Connecticut, outlined some of the qualifications of an engineer in the public service, and told of the difficulties he had encountered in finding technical men who were good enough business men and took a broad enough view of public affairs to make good. A. W. Dean, chief engineer of the Massachusetts Highway Commission, preferred a highway department with a single responsible head; he said, for efficiency there must be a military organization with each subordinate charged with definite responsibilities. H. W. Durham, chief engineer of highways in the Borough of Manhattan, New York City, described the highway organizations of Paris, London and Berlin, which he had recently been abroad to study. He concluded that results were less dependent on the kind of organization than on the personnel; subdivisions

of organization based on the classes of work were preferable to subdivisions into geographical districts. Written discussions were also presented by R. A. Meeker, engineer of the Department of Public Roads, New Jersey, and Paul D. Sargent, state highway engineer of Maine.

The New York State Highway Department organization was described by W. DeH. Washington, one of the three consulting engineers who reported recently upon its reorganization. He said in 15 years the state had had nine heads of the department. Under the new scheme of organization the overhead and engineering expenses were cut from 22% to 5 or 6%.

The question of the purchase of supplies was discussed and the sentiment seemed to be that all supplies peculiar to road work should be purchased direct by highway departments and not through central municipal purchasing bureaus. There appeared also to be a general belief that city highway departments did not have sufficient jurisdiction over street openings, subsurface structures, building encroachments, sidewalk obstructions, etc., responsibility for which is generally divided up among several city departments.

J. W. McConnell (Boston, Mass.) thought engineers needed to cultivate more of the arts of the politician in order to succeed in highway work. Geo. A. Ricker, first deputy commissioner of highways of New York State, gave an interesting account of the oral and written tests used to select the six new division engineers for the New York State work, for which positions there were about 150 applicants.

MATERIAL AND METHODS OF CONSTRUCTION—A paper by Paul E. Green, consulting engineer, Chicago, Ill., outlined a scheme for highway improvement based on a diagram he had prepared. The adaptation of local materials was an economic consideration, which, he thought, was often overlooked. Mr. Green's paper brought up a new point in discussions of this kind—an attempt to show that the æsthetic features of a road surface were important factors in its selection. This did not meet with much commendation, however, and it seemed to be the general conclusion that except for parkways æsthetic considerations were wholly out of the question. Another point discussed was an attempt to solve the problem of the paved width of roadway by empirical rules, based on the kind and amount of traffic; but a chart submitted for this purpose was held to be too local in character for general use.

Mr. Green's paper was discussed by Samuel Whinery, New York City, who thought æsthetic considerations very questionable in the economics of highways. Mr. Whinery spoke very strongly against the issuance of long-term bonds for temporary highway improvements, a practice which he said was inexcusable. The building of expensive pavements on country roads where in all probability a good dirt or gravel road was all that economic considerations justified, he looked upon as throwing away the public funds. He warned against the use of experimental materials except on a very small scale. Roads, he said, should be designed strictly on their value as an investment, and it was the duty of engineers to discourage the public in spending huge sums for temporary road surfacing.

Geo. W. Tillson, Brooklyn, N. Y., saw some value in the constant repetition of the theories and principles of road construction at various highway conventions; by such means the rank and file of the profession would become familiar with good practice. In discussing traffic censuses he brought up the point that there are types of pavement which suffer unless they have a certain minimum amount of traffic. Local economic considerations should always govern in the selection of a road surfacing, was his conclusion.

W. W. Crosby, Baltimore, Md., described an interesting failure of a park highway in Baltimore, which he laid to the pulverizing of the broken stone aggregate under the bituminous carpet surfacing. The failure occurred within 90 days after a road which had withstood several years of pleasure vehicle traffic was opened for heavy commercial vehicles.

A paper prepared by Capt. Mark Brooke, Washington, D. C., was read by the secretary. Capt. Brooke thought that it is very seldom an engineer is allowed much choice in the selection of a pavement; under the ordinary methods he is allotted a lump sum which has to be expended for a fixed mileage, so that the problem resolves itself into finding any kind of a pavement which can be constructed for the given cost. In Washington, he said, they were now using gravel concrete as a base for all pavements, except where there was an existing macadam pavement, which was sometimes used as the base. Expansion joints in concrete pavements and concrete bases he considered unnecessary; no trouble was experienced in Washington, where joints had been purposely omitted; in any event, the expansion joint should be very thin. No paved portion of a highway, he thought, should be narrower than to allow two vehicles to pass each other comfortably.

The question of the standardization of crushed stone was discussed by E. H. Thomes, New York City, and Mr. Whinery. Mr. Whinery stated that although a standardization of sizes was important, the question of the amount of voids in the rolled stone was far more important; many bituminous concrete-pavement failures, he said, could be traced to a lack of knowledge of the amount of voids to be filled.

The formation of waves in bituminous macadam pavements was discussed by W. W. Crosby, R. A. Meeker, W. De H. Washington and others. Various reasons for the so called harmonic waves were proposed, but the conclusion seemed to be that the waves were the result of inadequate rolling, rather than of the type of roller used, or of the character of the traffic.

EQUIPMENT AND METHODS FOR THE MAINTENANCE OF BITUMINOUS PAVEMENTS—This discussion was opened by W. R. Farrington, division engineer, Massachusetts Highway Commission, who divided the work into three divisions: (1) Ordinary repairs, such as patching, etc.; (2) retreatment with tar or oil; (3) reshaping and resurfacing. He outlined the Massachusetts practice in clearly expressed terms, and as, perhaps, there has been more experience in maintenance in this state than any other, his paper will be of much interest to engineers charged with this difficult task. Mr. Farrington's paper was discussed by A. H. Blanchard, who wound up his paper by recommending maintenance work by means of a carry-all motor truck, a life-size illustration of which was shown in the meeting hall and afterward explained in detail by W. De H. Washington.

W. H. Fulweiler (United Gas Improvement Co.) objected to Mr. Farrington's use of the commercial term "tarviaizing," and disagreed as to some of the methods of repair work done in Massachusetts. H. B. Pullar's

(American Asphaltum & Rubber Co.) paper advocated making patches on ahphalt and bituminous pavements by first burning off the old surface to a depth of a few inches. A heater designed for this purpose, he stated, had been used with success in several cities, and no harm had been done the surrounding pavement. He said, that in spite of many attempts, there had never been devised a successful method of treating the old material so that it could be used again.

There was considerable discussion whether repairs should be made with mixed aggregates or by the penetration method. Each method had its advocates, but the majority seemed to favor mixing. Among those who favored mixing was J. H. Sturdevant, division engineer, New York State Highway Department, whose paper was read by the secretary. Mr. Sturdevant stated that the mixing could be done at any convenient time, and the material so prepared could be kept for months without perceptible deterioration; reheating was all that was necessary for its subsequent use. T. H. Boorman, New York City, made a plea for rock-asphalt pavements, which he claimed were the most durable of any.

The effect of applying oil to tar-bound macadam pavements was discussed by P. D. Sharples, who stated that light oils should never be so used as to allow their penetration into the tar-bound aggregate, a mistake which, he said, was often made in the large cities where light oils were used for dust laying. The tar-seal coat should always be maintained, he said, by the occasional application of a heavy oil, or preferably a cold-tar treatment.

Special Committee Report of Am. Soc. C. E. on Bituminous Materials for Roads

The Special Committee on Bituminous Materials for Road Construction for 1913, presented a full report (dated Nov. 15, 1913) at the recent annual meeting of the American Society of Civil Engineers, held in New York City. The committee believes that there is no universal cure for all highway ills, no "most satisfactory road surface," but that the great problem to be solved by highway engineers is the proper selection of the particular material and form of construction which will best meet the needs of a particular case. In the abstract of the report, which follows, the small type represents the previous findings of this Committee, and the larger type its new recommendations. A nomenclature of about 100 terms is omitted. The Committee comprised W. W. Crosby, Chairman, H. K. Bishop, A. W. Dean and Arthur H. Blanchard.

CENSUS OF TRAFFIC—The traffic census should be considered one of the most important variable factors in the solution of that important problem, the selection of that type of construction best suited to local conditions considered from the standpoints of both economy and efficiency. In connection with the census returns on any highway, should be considered the traffic on cross and parallel highways and the effect of improvement of these highways on the traffic of the highway under consideration.

It should not be taken for granted that the bald return of a traffic census should be the sole basis of the selection of the type of construction, but it should be considered a guide in determining the value of the type adopted.

Where motor traffic forms a considerable proportion of the total traffic likely to use a highway, the unit width of traffic lines should be considered as 9 or 10 ft., instead of 7 or 8 ft. as heretofore, because of the greater clearance required for the safe passing of the units of such traffic.

In view of the recent constant and rapid increase of traffic on the highways, it will be in the interests of economy for designs of highways to be made with proper consideration of further increases.

COLLECTION AND STANDARDIZATION OF COST DATA —It seems urgent that standards for arriving at costs be established and generally adopted as promptly as possible.

CONSTRUCTION

GENERAL—The use of any form of a bituminous pavement or bituminous surface does not preclude the necessity for the construction of a well drained, thoroughly compacted and adequate subgrade. In fact, such improvement of the highway frequently attracts heavier traffic and thus increases the stresses in the subgrade.

Within certain limits of traffic the proper use of bituminous material should effect economy in the expenditures for the cleaning and maintenance. The proper treatment of a broken stone, gravel, shell, or slag road with bituminous material for the purpose of eliminating the so called dust nuisance will at the same time render even the best of such roads more efficient for sustaining traffic; and such treatment with bituminous materials is usually preferable and more economical than sprinkling with water, or the use of hygroscopic salts. An objectionable slipperiness of bituminous pavements or bituminous surfaces may be decreased or prevented by proper precautions during construction or by proper treatment later.

The crown generally used in the construction of broken stone roads is excessive when bituminous materials are used, and a crown of even ⅛ in. per ft. should be avoided when a lesser crown can be secured without detriment to the surface drainage.

MATERIALS—For the present, at least, whenever comprehensive specifications are to be prepared so as to admit a variety of types of bituminous materials, separate specifications as may be necessary should be prepared for each type.

Where bituminous pavements are laid, the edges should be protected and a sudden transition from the pavement to any softer shoulder material avoided by means of cement concrete or other edgings and such reinforcement of the shoulder material as may be necessary. The character of the stone to be used may influence the choice of the bituminous material.

By proper selection and use of the bituminous material, injury to property and deleterious effects upon animal and vegetable life may be avoided, and also considerable hygienic advantage may result from the use of such material on the highways.

The maximum amount of distillate up to 170° C. allowable in tars may depend upon the proportions of the other fractions in a tar, or upon the conditions of use of the tar, or upon the conditions on the road surface after its construction, or possibly upon some other factors.

METHODS—Selection of the method of construction to be used in a given case will depend upon the results of preliminary investigations; and the recent and imminent development of mechanical appliances will affect the decision to a great degree.

The main principles underlying perfection in water-bound roads remain in full force when such roads are treated with bituminous material. In all uses of bituminous materials in highway work, the use of proper machinery is preferable, wherever conditions make such practicable in any part of the process, to the use of hand labor.

The use or omission of a seal coat on bituminous pavements is dependent upon one or more of the following points: (a) The character of the bituminous material used; (b) the method of construction; (c) the density and quality of the

work done; (d) the kind and amount of traffic to be expected on the completed highway.

MIXING METHODS—Where the character of the traffic justifies the use of a bituminous concrete pavement, the same conditions demand an extraordinarily strong foundation therefor. The amount of bituminous material to be used in any case will depend upon the peculiar conditions of that case, such as the kind of road metal and of bituminous material, the character of the aggregate, the climatic conditions, etc. The character of the mineral aggregate to be used may be controlled by local conditions, but the best results can only be obtained by the use of the best materials. Excessive sizes, or excessive variations in the size of the mineral particles, should be avoided, and the utmost care must be taken to avoid the segregation of the different size particles.

Mixing machines should be used, and hand-mixing methods should be avoided wherever practicable. The success of results is greatly dependent on the degree of uniformity obtained in spreading the mixture and upon the proper rolling and compacting of the mixture. A too heavy roller should not be used.

Care should be taken in prescribing or laying any seal coat that invitation or excuse is not given for inferior prior work and its concealment by such a seal coat.

The use of fine sand on top of bituminous concrete is open to grave objections, and clean stone chips or small gravel free from particles that will pass through a ⅛-in. mesh seems preferable.

Trap rock in sizes greater than that passing a 2-in. screen, should be used with caution in the construction of the upper course unless the voids of the same are properly reduced because of the liability of the individual stones to rock under traffic. In the use of a heated aggregate for the construction of a bituminous concrete pavement, nonuniformity or excess in the heating of stone should be avoided.

PENETRATION METHOD—An important factor for successful results is the thorough compaction by rolling of the road metal before the spreading of the bituminous material.

The use of fine sand on top of the bituminous material is open to grave objections, and clean stone chips or small gravel, free from particles that will pass through a ⅛-in. mesh is preferable.

SURFACE TREATMENTS—The success of surface applications is proportionate to the adhesion obtained by the bituminous material to the old road surface, and such degree of cleanliness of the latter must be had, by means of sweeping or other methods, as will insure a proper degree of adhesion.

Whether or not the application of bituminous material is to be followed by an application of mineral material, and the amount of time to be allowed to elapse between the application of bituminous material and a subsequent application of mineral material, depends upon local conditions and upon the character and amount of the bituminous material used.

The use of fine sand on top of the bituminous material is open to grave objections, clean stone chips or small gravel, free from particles that will pass through a ⅛-in. mesh are generally preferable.

Attempts to construct and maintain by bituminous surface treatments a carpet of a greater total thickness than ½ in. have generally been unsuccessful, and in the construction of a successful carpet of a total thickness approximating ½ in. the materials should be applied in layers, at intervals, rather than by the construction of the total thickness in one application.

The amount of bituminous material to be used depends upon the local conditions in any particular case, but excess in any application is to be avoided, as a deficiency may be corrected by a subsequent application, while an excess in any application is difficult, if not impossible, of correction.

The success of results depends first upon the condition of the surface to which the treatment is applied. Even the best surface treatment cannot correct defects in the original surface, though it may reduce or modify them.

The application of the bituminous material by means of a pressure distributor is, wherever practicable, preferable to gravity or hand-pouring methods.

Considerable evidence seems to make undesirable in tars for superficial treatments, the presence of free carbon beyond a maximum, dependent on the distillate, between 170° and 300° C., in order to avoid brittleness at low temperatures.

The maximum amount of residue allowable in an asphaltic oil used for superficial treatment should be as great as permitted by the physical conditions of its use, subject to certain limits in the penetration of this residue; and such limits in penetration should be (1) a minimum which will insure against undesirable hardness or slipperiness under travel at low temperatures; (2) a maximum which will insure against undesirable softness or lack of body at the highest temperatures to be expected after use on the road.

Valuation of Public-Utility Property for Rate Making

A committee of the American Society of Civil Engineers was appointed in September, 1911, to formulate principles and methods for valuation of railroad and other public-utility property. The committee comprised F. P. Stearns, Leonard Metcalf and J. P. Snow, of Boston, Alfred Noble, of New York, T. H. Johnson, of Pittsburgh and W. G. Raymond, of Iowa City. H. M. Byllesby, of Chicago, was also appointed but was unable to take part in the work.

The result of these men's two-year deliberation was submitted in a progress report at the last annual meeting of the Society. At the close of this report there are 23 summarized recommendations which are reprinted below.

(1) REPORT LIMITED—This report is limited to the discussion of valuation for the purpose of rate-making. Valuations for other purposes differ in some respects, for legal and other reasons.

(2) GENERAL PRINCIPLES—The valuation should be such as to lead to equity as between the owner on the one hand and the public on the other. The rates should yield a fair return upon the fair value of the property. The owner, in addition to a reimbursement of the current expenses of operation, is entitled to (a) an annual return, covering interest and profit, for the use of his capital, having in view the risks incidental to the investment, and (b) an annual allowance to provide for the net depreciation in value of all the items of physical property, resulting from all causes, this allowance to be sufficient to pay for all items of property at the time they cease to have value. As earnings are based to a large extent upon rates, they cannot serve as a basis of valuation for rate-making.

(3) METHOD OF DETERMINING PHYSICAL VALUE—The Committee recommends the use of the actual reasonable cost, subject to suitable provisions for the cost of developing the business, for depreciation, etc., as the best basis for valuation of a new or recently created property, and in the case of an old property, the estimated cost of reproducing the property, with similar adjustments. As the actual cost of a new property should be substantially the same as the fairly estimated cost of reproduction of such a property, this is in effect a recommendation of a practically uniform method of valuation.

(4) FUTURE PROPERTIES UNDER CONTINUOUS COMMISSION CONTROL and suitable legislation could be valued best on the basis of actual reasonable cost, using book accounts for the ascertainment of the cost of developing the business and making proper charges in such accounts for de-

preciation. Under this method the corporation would avoid the hazard due to the rise and fall in prices.

(5) IDENTICAL PLANT SHOULD BE VALUED—The valuation should be predicated upon the identical existing plant, and not upon a substitute plant capable of furnishing equally efficient service.

(6) UNUSED PROPERTY—The Courts have indicated that the property to be considered in making a valuation for rate-making should be only that devoted to the public use. A commission may or may not permit the inclusion of a part or the whole of the unused property in the valuation, depending upon the basis adopted by it.

(7) REPRODUCTION SHOULD BE UNDER ORIGINAL RATHER THAN PRESENT CONDITIONS—The valuation should be based on the conditions existing at the time the various portions of the property were built, but on the prices prevailing at or near the time of the valuation. As the result of the adoption of this view, the cost of pavements laid over water pipes after their installation would not be included in the valuation, but the extra cost of piecemeal construction would be included. Ownership would not at all times control as to the property to be valued; for instance, a railroad built along the margins of a reservoir by a waterworks corporation as a substitute for one occupying the site of the reservoir would be valued, while service pipes belonging to the corporation, if laid at the expense of the ratepayers, would not be valued.

(8) INVENTORY—The inventory of the property should be made in detail and include an allowance for omissions varying in amount with the care and completeness with which it has been made. Due allowance should be made for the amount by which the actual overruns the theoretical.

(9) UNIT PRICES prevailing at or near the date of the valuation should be used rather than original prices, but to make a valuation more stable, the normal or average prices prevailing during a period of from five to ten years prior to the date of the valuation should be used, except where the prices are steadily rising or falling, when prices nearer the date should be used.

(10) OVERHEAD CHARGES should include the indirect and incidental expenses not covered by the unit prices used: Preliminary expenses, incidental to investigation, promotion and report; commission for sale of securities; incidental expenses during construction, including engineering, inspection and other fees, administration charges, general expenses, contingencies, and interest and taxes during construction. Such charges have frequently been under-estimated.

(11) DEVELOPMENT EXPENSES should be included in the valuation. They have sometimes heretofore been referred to as "Going Value" when this term has been defined as the investment necessary to put the plant into successful operation and to create revenues that justify its construction. They have also been defined as the difference between the actual return and a fair return upon the fair value of the property during the early years of the operation of the original plant and of subsequent additions. The development expenses connected with ordinary additions to a plant are a much smaller percentage than those of the original plant.

(12) WORKING CAPITAL—A reasonable sum should be included in the valuation for working capital.

(13) DEPRECIATION ALLOWANCE—The corporation is entitled to an annual allowance sufficient to pay for all items of property at the time they cease to have value.

(14) THE DEPRECIATED VALUE OF PROPERTY SHOULD BE BASIS FOR RATEMAKING—The depreciation allowance is in effect a re-payment in installments from the rate-payer to the corporation of a part of its investment in particular items of property, and the sums repaid should not thereafter appear in the valuation of such items.

[The main report shows that the annual depreciation receipts from rates are to be put into replacements, extensions, etc., or temporarily into working capital. The depreciation allowances are made such that they can provide funds for replacements of machinery, etc., only by earning 5% cumulative. This does not seem to remedy an apparent defect of the Committee's scheme, in that the rates are based on something less than "actual reasonable investment" in those cases where there is no evidence that compensation for the depreciation in security has been passed back in dividends, etc., by the utility to the investor. It seems to apply only to concerns which have always been under regulation, and where the depreciation allowances in rates are sufficient to (1) provide for replacements and (2) amortize that drop in value of equipment which no amount of repairs and replacements can make good.—Ed.]

(15) EXPECTATION OF LIFE is a necessary factor in determining depreciation allowances to pay for items of property during their life.

(16) EQUAL-ANNUAL-PAYMENT METHOD OF DETERMINING DEPRECIATION ALLOWANCES—The most desirable method is one which shall distribute the combined annual charges on account of the plant as equally as practicable among the rate-payers of different years; this result is reached by the Equal-Annual-Payment Method recommended by the Committee. By it the depreciation allowances for any given item of property are so adjusted from year to year that, when taken in connection with the amount which the ratepayer must contribute on account of such item for a fair return on the remaining investment therein, and for repairs and operation thereon, they are substantially equal each year.

Under this method the depreciation allowances are credited to the capital account, and not distributed as dividends, and replacements become charges against capital. The amount paid to the corporation annually for depreciation allowances would be used for additions, replacements, betterments, or the extinguishment of outstanding obligations, and when not needed for these purposes, would temporarily increase the working capital; the investment would be kept intact and earning a return on the full amount invested. This method conforms to the decisions of the highest Courts.

(17) THE SINKING-FUND METHOD assumes that returns are to be based on the full value of an item of property, and that uniform annual payments will be made to a sinking fund which is to be held intact with accretions of interest until the end of the life of the item in question. This method does not meet the requirements of the Courts in that they object to the establishment of sinking funds by public service corporations, and the highest Court has decided that returns must be based upon the depreciated and not the full value of the property. Sinking-fund computations are used to determine the depreciation allowances of the Equal-Annual-Payment Method, the allowances for each year being equal to the sinking-fund payment added to the interest on the accumulated fund at the beginning of the year.

(18) STRAIGHT-LINE, ACTUAL-INSPECTION, AND REPLACEMENT METHODS OF DETERMINING DEPRECIATION—The Straight-Line Method in the case of long-lived property distributes the burden very unequally among the rate-payers of different years, as will be seen by the table on page 40. The Actual-Inspection Method does not determine the amount of the annual depreciation allowance which the corporation is entitled to earn, and is likely to be unfair. The Replacement Method does not provide for paying for items of property during their life.

(19) APPRECIATION—Land and water rights generally appreciate in value from year to year. The Committee recommends that such appreciation be treated in the same way that the depreciation of the perishable property is treated, but on the opposite side of the account. Under present practice the appreciation generally inures to the benefit of the corporation, and it may not be feasible to carry out the Committee's recommendation except under necessary legal authority and continuous commission control.

(20) METHOD OF VALUING LAND—Land should be valued at present rather than original prices. On account of the difficulty of correctly appraising the value of public service land and of recent decisions of the highest Court, land which has been purchased at a fairly recent date should be valued on the basis of its cost with additions proportionate to the increase in the value of neighboring land not affected by the use to which the public service land is devoted. When it is not practicable to use the cost as a basis, land can be valued most correctly on the basis of present market value of neighboring land of similar character, augmented by the ratio ordinarily found to obtain in that region between land acquired by public service corporations, on the one hand, and by private parties on the other, and subject to the value of the improvements upon the land obtaining at the time of purchase. Those valuing land in cases coming before the Courts should pay due regard to the Minnesota Rate Cases.

(21) PAST EARNINGS—It is the view of the Committee that an excess of deficiency of past earnings of an unregulated property should not be considered in making a valuation, except as may be useful in determining development expenses; but, under continuous commission control and proper legislation, it would be desirable to take such earnings into account from the beginning of such control.

(22) ADAPTATION AND SOLIDIFICATION should be included in valuation to the extent they may have involved the expenditure of money. The increased value due to adaptation and solidification which has resulted from the action of the elements and natural causes without the expenditure of money should not be so included.

(23) EFFICIENCY SHOULD BE REWARDED—A physical valuation is not by itself a satisfactory basis for ratemaking, because it does not offer the reward for efficiency which sound public policy requires. The Committee believes that some incentive, such as a share of the profits or savings resulting from special efficiency, should be given to the corporation.

American Wood Preservers' Association

ANNUAL CONVENTION OF THE AMERICAN WOOD PRESERVERS' ASSOCIATION

The annual meeting was held at the St. Charles Hotel, New Orleans, La., Jan. 20 to 22, 1914, and we give below a review of the papers presented. The election of officers resulted as follows: President, George E. Rex, Manager of Treating Plants, A. T. & S. Fé Ry.; Vice-Presidents, Carl G. Crawford, R. S. Manley and F. B. Ridgeway; Secretary and Treasurer, F. J. Angier, Superintendent of Timber Preservation, B. & O. R.R., Baltimore, Md. The next meeting will be held at Chicago in January, 1915.

WOOD-BLOCK PAVING

The report of the Committee on Creosoted Wood-Block Paving presented a summary of replies to a circular of inquiry as to practice and experience in 48 cities. The wood used is yellow pine, tamarack, gum and fir, of which the first is used exclusively in 22 cities and the second exclusively in 14 cities. The depth of block is 3, 3½ and 4 in., the last being in the minority. As to oil, 43 cities use the specifications of the Association for Standardizing Paving Specifications; 22 recommend 16 lb. per cu.ft., exclusively, while others specify from 12 to 20 lb.

In regard to paving, 35 cities use a sand cushion, 11 a mortar cushion and 1 an asphalt cushion; 13 recommended laying the blocks tight, 29 preferred loose, and 3 medium; 28 recommended laying the blocks at an angle of 90° with center line of street, 13 at 66° and a few at 45°. All recommended an expansion joint at the curb, but differed as to the necessity of transverse expansion joints. For filler, 13 use pitch, 8 asphalt, 12 sand and 3 cement mortar, the others using two or more of the above. Only two cities oil the streets, 27 sprinkle with water, and 26 flush them or use rubber squeegees, while 20 have them dry swept.

In regard to troubles with this class of paving, 18 cities have and 27 have not experienced trouble from expansion, 24 have had trouble with bleeding for one to three years (only 3 for three years). As to slipperiness, 25 did and 21 did not have trouble; this trouble is generally only in cold weather or with dirty or wet pavement, or on steep grades, only one city reporting that the paving was slippery at all times. The conditions indicate the necessity of standard specifications for paving and standard rules for construction.

Other papers under this classification were on "The Construction of Creosoted Wood-Block Paving," by R. S. Manley (Creosoted Wood-Block Paving Co., New Orleans), outlining the methods to be followed, and "A Comparison of Wood Paving in Europe and the United States," by S. R. Church (Barrett Mfg. Co.). The former advocated a cushion of sand (sand and cement at steep grades and car tracks), tightly laid blocks, heavy rolling of the blocks to a smooth surface, bituminous filler for joints, and a surface coating of sand before admitting traffic. The latter paper referred especially to the foreign practice of laying the blocks upon a carefully surfaced concrete base, the use of 5-in. blocks, and the great care with which the paving is done. We shall publish abstracts of these papers.

RAILWAY TIES

SUPPLY OF WOOD TIES—In a paper on "Future Tie Material in the United States," Mr. Gibson (*Hardwood Record*) pointed out that the main demand now is for ties for renewals rather than new construction (7 to 1), and that this must be supplied from the timber resources, as other materials are used only to a negligible extent. But only certain species and certain trees of these species are suitable, the trees being either too small or too scarce, and the timber either unsuitable or needed for other purposes. Oak represents about 50% and pine about 15% of all the ties used. The railway-tie plantations do not produce enough to be considered, and the forests must continue to be the source of supply.

The remedy is in preservation of the timber, which will then average double its former life, while inferior timbers can be used with economy when treated, and if they are too soft to stand wear, they can be protected by tie-plates. In the author's opinion there is no immediate emergency, but the policy of using treated timber should be adopted at once and followed consistently.

PROTECTING TIES FROM WEAR—A paper on "The Protection of Ties from Mechanical Destruction," by Howard F. Weiss (Director of the Forest Products Laboratory, Madison, Wis.), pointed out the increasing use of ties made from the softer woods. Statistics of the American Railway Engineering Association indicate that the proportion of ties failing from mechanical destruction rather than from decay ranges from 10% in oak to 75% in cedar. It is wasteful to treat the softer ties against decay unless they are so protected against wear as to give them full life in service.

The mechanical wear is due to the rails and the spikes. The former is in the form of direct crushing and abrasion, and may be prevented by the use of metal tie-plates large enough to distribute the pressure and heavy enough to resist buckling under load. Spike cutting of the wood may be reduced by using screw spikes (which are more expensive) or by inserting hardwood plugs or dowels, into which the spike is driven or screwed. Where ties are adzed or bored, this should be done before the treating process.

In a paper on "Observation and Inspection of Experimental Ties," Mr. Waterman (Superintendent of Timber Preservation, C., B. & Q. R.R.) outlined the condition of some 26,000 ties that have been in the track for four years. The ties are treated with zinc, zinc-creosote and creosote. Not one has been removed for decay and a life of 12 to 15 years is anticipated. On the other hand, over 80% of untreated ties laid at the same time and alternating with the others have been removed on account of decay. Of 35,000 zinc-treated red-oak ties laid in 1903-04, 60% have given ten years' and over 90% have given nine years' service. Some of these have been removed on account of being cut by rails, which could have been prevented by the use of tie-plates, and as a result these plates are now being used on all treated ties.

On some other roads, zinc-treated ties have failed in

three years, but this is due to imperfect seasoning and not to the preservative treatment. To quote Mr. Waterman, "they were on the stump today, tomorrow in the retorts, and the next day in the track." Such work only casts discredit on preservative treatment in general. There was a paper also on "Methods of Keeping Tie Records," by E. T. Howson (*Railway Age Gazette*).

Wood-Preserving Methods and Plants

Air Pumps and Hydraulic Pumps for Injecting Preservatives—This paper was by F. J. Angier (Superintendent of Timber Preservation, B. & O. R.R.). Hydraulic pumps are used at most plants, but the Baltimore & Ohio R.R. plant at Green Springs, W. Va., uses the air pump, and compressed air (with different apparatus) is employed also at the Chicago & Northwestern Ry. plant at Escanaba, Mich. In the former case, the preservative is charged into a tank from which it is admitted to the treating cylinder, and when the latter is filled the air pump creates a pressure in the tank and therefore in the preservative in the cylinder. The advantages claimed for the air pump are less apparatus, less maintenance of apparatus, less attention in operating, less steam consumption, and a more steady and constant pressure. The air-pump equipment has a slightly higher cost of installation, but it is considered that in the end it is more economical.

Preliminary Vacuum or Pressure—A paper on "The Effect of Varying the Preliminary Pressure in Treating Ties," by Clyde H. Teesdale, of the Forest Products Laboratory, Madison, Wis., related to a group of experiments made at the laboratory. These were to determine the effects of varying the air pressure in the cylinder prior to impregnation with creosote: (1) the absorption during the filling and pressure period; (2) the oil recovery from the wood while the oil pressure is being reduced from maximum to atmospheric; (3) the recovery due to drip and final vacuum; (4) the uniformity of treatment in the ties forming the charge; (5) the diffusion of preservative through the wood; (6) the diffusion of air pressure, vacuum and oil pressure through the wood. The experiments consisted of a series of runs with ties of hard maple, red oak, hemlock and loblolly pine. The general conclusions were as follows:

1. The absorption during the filling and treating period was least when no preliminary vacuum or air pressure was used and greatest when high pressures were used.

2. Preliminary air pressures did not materially increase the time of the oil-pressure period to secure the required absorption, except in hemlock.

3. Loblolly pine required the shortest pressure period to reach the desired absorption. Maple ranked next, and then red oak, while hemlock required a comparatively long period.

4. The smallest recovery of oil was obtained when a preliminary vacuum was used; and the highest recovery when high preliminary air pressures were applied.

5. A final vacuum had no marked influence on the amount of drip recovered, except in the case of loblolly pine. But it hastens recovery, saves oil that would otherwise drip on the ground, and renders the timber cleaner to handle.

6. The distribution of preservative through the wood apparently was not influenced by preliminary vacuum or air pressure.

Supplementing the tests on the experimental cylinder some tests were made at the creosoting plant of the Pennsylvania R.R. at Point Greenwich, N. Y. The results were much less refined than in the former tests, many factors being less easy of control in the commercial plant, but they indicated that the above conclusions would hold true in work on a commercial scale.

Other papers relating to wood-preserving plants were as follows: "The Construction of Tram Cars," by J. H. Grow (Allis-Chalmers Mfg. Co.); "Methods of Separating Water from Creosote Oil," by Thomas White (Assistant Manager, American Creosoting Works); "Advantages of Piling Wood Blocks Closely in Cages," by R. H. White (President, Southern Wood Preserving Co.); and "Mechanical Handling of Ties and Timbers," by Lambert T. Ericson (Assistant Superintendent of the Port Reading creosoting plant of the P. & R. R.R.). This last related to the use of 20- and 30-ton locomotive cranes at this plant. In a paper on "A New Type of Plant for Treating Paving Blocks," J. B. Card described the plant of the Chicago Creosoting Co., at Terre Haute, Ind., which has vertical tanks 11 ft. in diameter and 14 ft. high instead of the usual horizontal tanks. This construction is patented. The tops of the tanks are 38 ft. above the ground, the blocks being charged into them by an inclined conveyor.

Miscellaneous

Fireproofing Wood—A paper by Robert E. Prince, of the Forest Products Laboratory, Madison, Wis., outlined experiments as to the commercial treatment of wood by some economical process to render it fireproof. Of eight species of wood tested without treatment, tamarack was the most fire-resistant, with redwood next, although western larch and noble pine were slower to ignite than redwood. As to the treated wood, the conclusions were as follows: (1) Ammonium salts are of considerable value, it being impossible to ignite the wood under test conditions; (2) borax has less value, but promises a means of reducing cost of treatment by using it with another salt of higher value; (3) it appears possible to devise a reasonably inexpensive method of rendering wood fire-retardent.

Treating Wood According to Conditions of Use—This paper, by E. L. Powell (Vice-President, American Creosote Works, New Orleans), pointed out the importance of greater care in adapting the treatment and the quantity of oil to suit the conditions of timber, soil, climate and use. Many specifications for treatment are imperfect, and he considered that the wood-preserver is, in general, better able than the engineer to adapt the specifications to the above conditions. He should consult with the engineer as to the conditions of use, make recommendations as to proper treatment, and refuse to work to specifications calculated to produce unsatisfactory results.

The Committee on Preservatives submitted as information a number of specifications now in use, and recommended that in view of the various specifications in use or proposed, it is not advisable at this time for the Society to adopt any form of its own. Also, that in future work the committee should be instructed to confer with other similar committees with a view to obtaining uniform standard specification for oils.

The Construction of Creosoted Wood-Block Pavements*

By R. S. Manley†

The correct depth of concrete base or foundation varies with the soil conditions, but the materials and the methods of mixing are in such common use as to be standard and easily secured. We are interested principally in the construction placed on top of the concrete. The principal causes of defects of more or less serious nature are: 1. Irregular or uneven surface, due to careless laying, shifting of sand cushion, or breaking or settling of concrete; 2, expansion due to the entrance of water into the blocks either by way of the joints or from below.

An irregular or uneven surface is death to any paving material, because a depression in the surface holds water and repeated churnings of wagon wheels in the depression are bound to cause an enlargement and deepening of the depression.

The concrete of the base should be mixed quite wet and finished smoothly with a flat wooden spreader which gives a surface practically as even and uniform as could be obtained by template. On this should be spread ½ to 1 in. of clean sand, making the sand cushion conform to the contour of the finished street.

Then place the blocks quite close together, and roll thoroughly until a perfect surface with no inequalities has been obtained and until the blocks are firmly in place. It will require a great deal of rolling to accomplish this, but the end justifies the means. After this, fill all joints two-thirds full of hot bituminous filler of such melting point as is suited to climatic conditions, and spread a thin coating of sand. The use of the bituminous filler is most important. It converts the street into an effective watershed which without absorbing any of the water, directs it into storm sewers or other drainage paths. Should any water remain on the surface, the wind and the sun will rapidly dissipate it.

This construction gives an even waterproofed surface. This surface cannot be worn by traffic because the pressure of wheels is even and regular and there is no dropping or jolting of wheels entering and leaving low spots. As the blocks are laid tightly, there is no wearing at the joints. There can be no change in the sand cushion as long as the surface remains intact, a solid sheet in fact of wood block cemented together by the filler. It is assumed that the concrete is sufficiently strong so that it will not break or settle.

Expansion difficulties are eliminated by the use of bituminous filler, for there can be no expansion without absorption of water, and no absorption of water when all rainfall is conducted quickly to drainage sewers. In addition to this it must be remembered that with the bituminous filler each block is surrounded by an individual expansion joint.

Another method of construction is to provide a mixed sand and cement cushion, and sand-filled joints or interstices. This cushion does not give the opportunity for absolutely smooth surface that the sand cushion gives, and is considerably more costly. The sand filler in the joints allows moisture to be absorbed in the pavement and ultimately this moisture gets into the blocks and trouble ensues. It is only on sheets of extremely heavy traffic that sand can be used as a filler without some expansion difficulties sooner or later.

It can be stated without fear of successful contradiction that every sand-filled pavement in the South has at one time or other given trouble from uncompensated expansion, and with equal confidence it can be stated that not one bituminous filled pavement has given trouble from this cause.

There have been objections put forward to the bituminous filler because of the belief that it would produce a sticky surface, disagreeable in warm weather. But if the proper filler is secured, and it is correctly applied there can be no such objection. The suitable filler has a consistency of rubber and can be taken in the fingers, bent and twisted without soiling the fingers. In applying this filler a spreader with squegee attachment places the filler in the joints where it is needed, and not on the surface of the blocks where it is not needed.

It is proper also to use less creosote oil per cubic foot of timber when bituminous filler is used, for the primary function of the creosote oil in this case is to preserve against decay instead of trying to make the creosote oil fill the double purpose of preservative and absolute waterproofer. No one familiar with preservative methods and history will question the efficacy of 16 lb. of creosote oil per cu.ft. in preventing against decay for an indefinite period.

The method of construction may be summarized as follows: Provide adequate smooth concrete foundation, use enough sand to cover any inequalities in the concrete or depth of blocks (except in railway areas and on grades when use sand and cement mixed), lay blocks tightly, roll until smooth, fill joints with bituminous filler, spread coat of sand, and turn on the traffic.

*Abstract of a paper read at the annual meeting of the American Wood Preservers' Association, at New Orleans, Jan. 20, 22.

†Creosoted Wood Block Paving Co., New Orleans, La.

Wood Paving in European Cities*

By S. R. Church†

It has been stated that creosoted wood blocks would make the ideal pavement if the following faults could be eliminated: 1, the tendency to expand, resulting in bulging, and sometimes upheaval of the pavement; dislocation of curbs, etc.; 2, slipperiness; 3, bleeding of oil. Of all the wood pavements that I saw in London, Paris, Berlin and other cities, none exhibited any of the foregoing defects, with the exception of two or three slight bulges noticed in London.

WOOD PAVING IN ENGLAND

Creosoted wood is the most highly esteemed paving material in the English cities. In ten of the 28 boroughs constituting the city of London, and comprising the most thickly populated sections of the city, the total mileage of creosoted wood block in 1912 was 121, of this total, 40 miles was in Westminster, where the streets are important thoroughfares, but the traffic is very largely of rubber-tired vehicles. Liverpool has about 150,000 sq.yd.; Birkenhead, 95,000 sq.yd. In fact all English cities over 50,000 population have wood paved streets and in most cases these are the principal thoroughfares.

Two classes of wood are used; soft and hard. The hardwoods are ordinarily untreated; they are going out of favor and the existing hardwood pavements are, as a rule, rough and noisy. These pavements comprise the Australian jarrah and karri, species of eucalyptus. Great things were hoped of these woods when first introduced, but their use has unquestionably proved a failure.

The creosoted softwood pavements presented, in general, a good appearance, but not equal to the appearance of our best wood block streets. They were not slippery, because the wood is soft enough to permit the pounding into the fiber under traffic of the gravel or coarse sand which is spread over the pavement, and the pieces of grit become permanently embedded in the surface of the wood. It can be readily appreciated that the surface will not present as attractive an appearance, nor would it be quite as noiseless as our creosoted yellow pine.

The wear of the blocks is, in general, very uniform, and but few streets are seen where depressions, pot-holes or inequalities in the surface exist, although in the downtown streets of London proper, where traffic is heaviest, there are several exceptions to this general good condition. From a casual observance of the wood-block surfaces in London, one accustomed to the appearance of our pavements marvels at the apparent absence of replacements. It requires very close scrutiny of the pavement to find the places where service cuts have been made, and where the pavement has been patched. The great care with which this work is done to produce such good results is in marked contrast with the careless manner in which the blocks are sometimes thrown back into place after a service cut in one of our city streets.

MANUFACTURE OF WOOD BLOCKS IN ENGLAND

I was able to visit the treating plant of one of the most important paving block companies. They are using almost exclusively wood of the class known as "pinus sylvestris," and which is sold under various names, such as "Swedish pine," "Baltic pine," "yellow deal," "red deal," etc. This is a most uniform appearing wood, block after block could be examined without any noticeable difference in weight, size of rings, freedom from knots, shakes, etc., nor is there as marked a difference apparent between heart and softwood as in our yellow pine. The manager of this company told me that he has made a study of wood for many years, and has been all over the world, and that in his opinion this Baltic pine is the ideal paving block wood, and to it he ascribes the success of their pavements.

*Abstract of a paper read at the annual meeting of the American Wood Preservers' Association, at New Orleans, La., Jan. 20, 22.

†Manager of Research Department, Barrett Mfg. Co., New York, N. Y.

The methods in the plant appear to be thorough and well regulated, but not nearly as up-to-date mechanically as our American works. The saws are small; the treating cylinders are small, and there is a great deal of hand labor. Straight pressure treatment is used. The average treatment is about 10 lb. per cu.ft. The city of London now requires 12 lb., and the city of Westminster 10 lb. The oil is coal-tar creosote oil, said to be about 1.06 specific gravity. Specifications are very simple, and there is practically no inspection at the plant.

Considering the apparently light treatment, the penetration of the oil is exceedingly good. The storage capacity for untreated or treated material at the plant is small, so that the wood is not seasoned very long before treatment.

LAYING WOOD PAVING IN LONDON

In company with G. W. Tillson, Commissioner of Public Works, Brooklyn, N. Y., I observed the construction of a wood pavement in Gracechurch St., London. We were greatly impressed with the good workmanship displayed. The street is in the heart of the old city, and is 34 ft. wide. It was being paved for a distance of about six blocks. The contractors were allowed to shut the street off from traffic for a definite period of time, within which the work must be completed.

The old asphalt pavement had been entirely removed, and a new 9-in. concrete foundation was put down in sections about 25 ft. long, and the full width of the street. It was laid in one course, with a very wet mix. The concrete surface was finished to a true grade by means of a wood templet, and without the use of any mortar course. Sometimes a mortar course is used to make the surface smooth. In all cases the concrete is allowed to set six or seven days until perfectly hard.

The blocks are then laid directly on the hard, smooth concrete, without any cushion. This is universal practice, not only in London, but in Paris and Berlin, and all the engineers with whom I talked were opposed to the use of a sand cushion or a soft cushion of any kind. The blocks were 5 in. deep, 3 in. wide and 7 in. long. They were very uniform in length and exceedingly true in depth. They were laid fairly close, but not rammed. A 1½-in. expansion joint was provided along either curb, and two rows of blocks laid parallel to the curb, with a pitch-filled joint between these rows. The expansion joint was filled with clay to within ½ in. of the top.

Before paving up to projections, such as manholes, pipe valves, etc., the blocks are fitted with great care around all these projections. Over the finished surface a flush coat of hot coal-tar pitch, of about 140-145° F. melting point, was poured from hand buckets, and this was immediately squeegeed over the surface with rubber rollers, forcing it into all the joints. This was followed with a thin wash coat of cement grout, and finally a substantial layer of fine, brown, siliceous gravel, free from dust or loam. This was allowed to remain on the surface until pounded into the blocks by traffic.

The practice of using spacing lath in the joints has been abandoned in England, except in the case of some hardwood pavements. The spacing strips are never used in London or Paris with softwood blocks. They are, however, used in Berlin. The flush coat of pitch over the surface is the universal practice in England, although not used to any extent elsewhere. Longitudinal expansion joints are always provided, even on heavy traffic streets, but lateral expansion joints are not used. In London, 5-in. blocks are used on all important thoroughfares, and no blocks less than 4 in. deep are ever used.

WOOD PAVING IN PARIS

Creosoted wood-block paving in Paris is more noticeable for quantity than it is for quality. At the end of 1911, they had about 280,000 sq.yd. of wood paving. As in England, they have used both hard and soft woods. The Australian hard woods were used to a large extent, but have not given satisfactory results. The report of the Chief Engineer of Bridges and Streets of Paris, at the London Road Congress, stated that the average life of the hardwood paving was six years. The appearance of the creosoted pine pavements in Paris varies from good to exceedingly bad. There are many streets where the blocks are decayed. There are also many very rough streets, and on the whole, they are distinctly inferior to the wood-block streets in our American cities.

The method is much the same as in London, using 5-in. blocks. The concrete foundation is very similar in appearance, and the absence of any soft cushion especially noteworthy. Expansion joints 1½ in. wide along the curbs are filled with sand. Two rows of blocks are laid parallel to the curb with 1 in. between the rows, a peculiar type of sectional expansion joint being used, consisting of a bituminous paper box about 6 in. long, containing hollow paper cylinders. This keeps dirt, etc., out of the joint, and crushes readily under pressure.

Transverse joints about 100 ft. apart are also filled with these bituminous boxes. On another street a collapsible metal expansion joint is used. Instead of pitch grouting, it is common practice to flush the surface with cement grout, which fills the joints that are open. The work did not seem to be as well organized or as rapidly carried on, nor did the surface of the finished pavement present as uniform an appearance as the London work already described.

In another street, on a grade of at least 2½%, the surface was flushed with coal-tar pitch poured by hand, and forced into the joints by the use of hot smoothing irons. This was followed by a heavy covering of coarse sand. This method of filling joints is not as common in Paris as the cement grouting method.

MANUFACTURE OF CREOSOTED PAVING BLOCKS IN PARIS

The municipal wood block plant is a very large and well ordered plant, and the first thing that attracts attention is the very high lumber piles, which approximate 40 ft. The sticks are run up into these piles direct from the cars by means of an electric tiering machine. A large proportion of the lumber is kept under glass roofs. There is also a very large storage yard for treated blocks. A new electric driven machine, which saws 16 blocks at once, is a feature of the plant. The sticks are fed automatically to the saws, and the blocks are discharged automatically with the grain up, to the inspection table, from whence they are loaded by hand into very small iron treating cars.

Five or six of these cars full of blocks are run under the creosote oil tank, where each car is filled by gravity with oil at a temperature of 80° C. After remaining in this bath for 20 min., the oil is drawn off from the bottom of the car, and the blocks taken to the storage yard. The average absorption by this treatment is 3 lb. per cu.ft. Naturally, the penetration is very slight. It is not surprising that the blocks decay before they are worn out, but at first sight it is surprising that they do not bulge and buckle continually.

An interesting feature is the machine for shaving old blocks for relaying. Blocks not too badly worn or decayed are brought to the plant and have the edges trimmed on these machines. It is sometimes done with portable machines on the streets. Many of the blocks being repaired in this manner for relaying showed hardly any evidence of treatment, and some were partially decayed.

The Paris engineers admit that their blocks have been very insufficiently treated, and that the results have been unsatisfactory. In fact, they are now erecting a new plant for pressure treatment by means of a process developed by M. Labordere and described in a paper before the Sixth International Congress of Testing Materials. It is the intention to use in connection with this process, a mixture of coal-tar pitch and creosote oil of not less than 1.08 specific gravity. They have been using for the dipping treatment an oil of about 1.04 specific gravity.

The woods used in Paris for creosoting treatment are Baltic pine, and maritime pine, a native pine largely used at present. This is a much wider grained wood than the Baltic pine, and less uniform in character. They make an interesting distinction between the resinous or gummy wood from the lower part of the trunk, and the wood from the upper part of the trunk, using the former for heavy traffic streets and the latter for ordinary work.

WOOD BLOCK IN BERLIN

There is not much wood block paving in Berlin, but a condition which seems rather remarkable exists, in that on streets paved with asphalt, wood-block paving is used where the grade becomes too steep and the asphalt will prove unduly slippery. Most of the approaches to bridges are paved with creosoted wood block. This city has probably the finest sheet asphalt paving in the world. The wood paving is rough and comparatively noisy. About the only thing of special interest noted was that a new wood block plant has been erected where the Rueping process will be used for treating Swedish pine similar to that used in England.

SUMMARY AND CONCLUSIONS

I have stated that European wood pavements did not bleed, expand or buckle, and were not slippery. The conditions are so entirely different that I do not see how any direct comparison can be made. As to slipperiness, I have already explained that the nonslipperiness of their pavements is due to the use of softer wood. As to bleeding, they seldom have any weather in London hot enough to cause bleeding. In Paris there is not enough oil in the blocks to cause bleeding.

The climate also undoubtedly plays a very important part

in the question of expansion and contraction. It is agreed that the sudden expansion that sometimes takes place in our wood pavements is due to a rapid absorption of moisture, usually after the pavements have been unduly dry. This can hardly occur in England, where they have a little rain all the time, very seldom any torrential downpours or any long continued dry spells. The average humidity is high. It is a question whether the pavements ever get dried out to anything like the extent that ours do. I should say that generally the blocks are in a maximum condition of expansion. The same must be true in Paris, or the inadequately treated blocks in that city would certainly bulge.

On the other hand, it is well worth considering if the kind of wood they use has something to do with the lack of expansion troubles. It is manifestly a very different wood from our longleaf yellow pine. It does not present as attractive an apperance, and it is probably not so durable. It may be, however, that with shortleaf pine or tamarack or Douglas fir, we could obtain results more nearly approaching the European results by following their practice more closely with regard to treatment and methods of laying. We can afford to give careful consideration to the question of lighter treatment, but I do not believe that because 10 or 12 lb. is ample in London with the wood they are using and the climate that exists, it would be ample for our woods in our climate. The points especially emphasized for consideration are as follows:

1. The great care used in the preparation of the concrete foundation and in the whole workmanship of the pavement; 2, the general use of deeper blocks; 3, the universal practice (in England) of sealing the joints of the pavement with coal tar pitch, so as to prevent the entrance of moisture. The pavements in Europe (this does not apply only to wood) are laid and maintained by workmen who take greater pride in their work than we find on the average job in our country. There is less inspection on the part of the city of the operations of making the blocks and laying them, but I got a very strong impression that the manufacturers are taking no chances of having their material condemned on account of carelessness or bad workmanship.

Annual Meeting of the Indiana Engineering Society

The annual meeting was held at the Severin Hotel, Indianapolis, Jan. 22 to 24, with a good attendance and a good list of papers. The total registration was 115, including visitors. The first evening was devoted to the annual dinner, with music and entertainment, the latter including moving pictures of the construction work on the Panama Canal. The President, H. O. Garman (Indianapolis), Chief Engineer of the Indiana Public Service Commission, occupied the chair at the meetings. The list of papers and committee reports was very long, and it was impossible to present all of these in the time available.

In a paper on "The Testing of Commercial Sands," Prof. Scofield (Purdue University) expressed the opinion that too little attention is given to the sand used in making concrete, and that some failures or unsatisfactory results which are attributed to the cement are more likely to be due to the sand. For work of this kind, the sand should be tested with the cement with which it is to be used on the work. Mr. Luten (Indianapolis) presented the advantages of the concrete arch bridge over other types, and suggested certain changes in the Indiana bridge law to insure good designs and fair letting of contracts. He illustrated several concrete bridges built to replace steel bridges washed away by the floods of the spring of 1913.

A paper by Mr. Mueller (Newcastle, Ind.), on "Bridge Foundations in Gravel Channels," related particularly to the danger incident to erosion by swift currents, and the necessity of carrying the foundations deep enough for security under such conditions. For the foundation piling, concrete has the advantage of being safe where it is alternately wet and dry, while the cost of wood piling in long lengths was said to approach that of concrete pil...

Prof. Albert Smith (Purdue University) discussed two matters relative to steel bridges: (1) the permanent distortion of vertical posts due to secondary stress, and (2) the common specifications for wind stresses in end posts. Prof. W. K. Hatt presented a paper on the new Main St. bridge at Lafayette.

A paper by W. K. Eldridge (Indianapolis), on "Comparative Tests of Concrete Columns," disputed the idea that the total superimposed load can be divided into two portions carried separately by the concrete and the steel in proportion to the ratio of elasticity. This idea was said to be negatived by the results of tests, and the bending of the rods under excess compression was assumed as a cause of splitting and fracture of the concrete. In his opinion, vertical rods should not be considered as factors in direct primary compression but should be employed only as tension members to take up tension due to lateral bending. This method is followed by the author, and while it increases the size of the column, the additional cost is offset by a saving of steel. His conclusion is that the design should be based on the following: (1) a direct compression load over the entire cross-section of the column; (2) verticals taking care of lateral flexure but not stressed more than the concrete in compression; (3) hooping to take care of internal stresses derived from deformation but not acting in direct compression or lateral flexure.

Nearly an entire session was devoted to the allied subjects of public-utility commissions and property valuation. An address on "The Work of the Indiana Public Utilities Commission" was given by Hon. Thomas Duncan, chairman of the commission. Touching upon valuation, he said he had been surprised at the different values for the same property presented by engineers of corporations, municipalities and the commission. In his opinion, this was due to prejudice in favor of one side or the other, which should be so eliminated that the several engineers would arrive at substantially the same valuation. C. C. Brown (Indianapolis) pointed out, however, that valuation or appraisal is not an exact science, and that a buying valuation is a very different proposition from a selling valuation, while a rate-making valuation is different again. For these reasons such a result as suggested by Mr. Duncan cannot be expected. Other papers on the subject were presented by H. O. Garman, Chief Engineer of the Indiana commission, and by W. J. Huddle (Indianapolis), and were followed by considerable discussion.

A paper on "Isolation of B. Coli from Water," by Prof. Hilliard (Purdue University), brought the explanation from C. C. Brown that the coli may come from other than human sources and that their presence in water does not necessarily mean the presence of the typhoid bacillus, although it does mean that the quality of the water is suspicious. Prof. Hanna (Indiana University) described "The Sewage Disposal Plant at Bloomington, Ind.," which has octagonal tanks and sprinkling filters. Several papers were presented on the Indiana floods of last March, and J. A. Craven described the proposed relocation of the White River through the city of Indianapolis and the sanitary survey made of the city. There was also a paper on the field work of the Ohio River Survey, by G. C. Graeter.

The question of public roads received considerable attention. Mr. Kenyon (Indianapolis) showed the enormous annual expenditure on road work in Indiana and thought it deplorable that the State has no engineer or other official to supervise the work of construction and maintenance or to exercise any control over the expenditures. A state highway department and engineer have been advocated for several years, but the legislature has taken no action. Mr. Blunk (Martinsville) had a short paper on "Brick and Concrete Road Building," and the advocates of brick and concrete paving presented the advantages of their respective materials and methods of construction.

A short paper by E. D. Cloud (Chicago) discussed "The Economics of Block Signaling," and Prof. D. D. Ewing (Purdue University) presented a summary of "Steam Railway Electrification," briefly describing the different systems used and comparing their advantages and disadvantages. Among the advantages of electric traction as compared with steam are safety in operation, increased track capacity, higher gross earnings, and greater adaptability to service. Among the disadvantages are high first cost (and consequent high fixed charges), and the fact that the engines are not independent units. In a rather brisk discussion Prof. Wallace (also of Purdue University) championed the steam locomotive with its increased economy due to superheaters, mechanical stokers, etc., and thought while gross earnings might be higher with electric traction, the steam locomotive yielded higher net earnings. A short paper by Otto N. Mueller described a proposed railway terminal and warehouse at Indianapolis, having two buildings of reinforced-concrete construction, with tracks between them.

Officers

The officers for 1914 are as follows: President, Prof. Albert Smith, Purdue University, Lafayette, Ind.; vice-president, James B. Short; secretary, Charles Brossmann, Indianapolis, Ind.

Some Experiences of an Engineer on a Public-Service Commission*

By James E. Sague†

When I became connected with the New York Commission, I was struck at once by the enormous extent of the territory which we are supposed to cover. I wondered how any one set of men could cover it satisfactorily.

The answer to that is that they cannot do it; they cannot do it with the best help that they can gather around them. They have to get all of the help that it is possible from high-minded corporation officials, by daily touch, by informal conferences and by frank discussions at hearings.

A section of the law which interested me especially was the following one:

> Each Commission shall have the general supervision of all railroads and electric corporations, etc., within its jurisdiction, and shall have power to, and shall examine and keep informed as to their general condition, capitalization, franchises, and the manner in which their lines and property are managed, conducted and operated, not only with respect to the adequacy, security and accommodation afforded their service, but also with respect to their compliance with all provisions of law and orders of the Commission, and charter requirements.

That is a large proposition. I heard Dr. Humphreys make an address shortly after these New York Commissions were appointed, in which he said that 50 men could not begin to do the work that was laid out for us, and I have often thought that he was pretty nearly right. I discussed this part of the law with one of my friends, and as I recollect his words, they were, "That sounded good to the Legislature, but you will find that it has been sleeping in the railroad law for many years, and nobody has paid much attention to it."

But now the public have reached the point where somebody must pay attention to it, and commissions have got to be organized in such a way that they can do the work with a fair degree of propriety and efficiency, or else they must be pushed aside.

I think the lack of success which has so often attended the work of regulating commissions, is due to their failure to develop along these lines, and a tendency to substitute the methods of the courts for those of informal study and investigation.

Nevertheless, if we look back over a period of 25 years, and study the history of the Interstate Commerce Commission, I think we will find that two great things have been accomplished: First, a systematic tariff has been instituted, and the publicity of railroad rates has absolutely stopped, as I think, discriminations and rebates. This of itself seems an important task, but aside from this, a system of accounts has been instituted, which enables corporations to be compared on the same basis, and practically compels honesty in reporting.

Now, this system, elaborated and developed as it has been by the Interstate Commerce Commission, along the lines referred to, I feel justifies the creation and maintenance of that Commission, if they had done nothing else. But we all know that they have done a great deal in reconciling controversies between the shippers and the railroads. This example has been followed by many of the state commissions, and I think along this line a great deal of success has been accomplished.

I have had a good deal of occasion to study balance sheets in the last six years. I did not know much about them before and perhaps do not know much about them now, but I was astonished very much by the apparent fact, that those balance sheets did not mean anything at all, as far as indicating the amount of money which had been actually invested in the property. There was an item there, "cost of property" but that usually represented only the amount necessary to balance the liabilities and surplus, and often bore no close relation to the amount of money invested. I think that you will be astonished to note the complete change that has been carried out. One of the main functions of the commissions has been to insist that corporations tell the truth about their affairs, and I think that this part of the work has on the whole been well done, and will prove of the greatest value, not only to the community, but to the corporations themselves.

I do not believe it would have been possible to formulate the system of accounts now in vogue if it had not been for the unselfish and tireless interest and application of the accounting officers of the companies with which we deal. This, in itself, is a tremendous step forward, and goes far to justify the organization and maintenance of the state and interstate commissions.

In other respects, however, I think the work of the average commission leaves much to be desired. In the first place we spend too much time over minor complaints. It is rather astonishing how much effort is given to them. There is some good reason for it. Occasionally a man who has a complaint is a constituent. In another case, he is apt to go to the governor in a fiery letter, and the governor is apt to file the letter with the commission and inquire why progress is not being made. And there are other considerations, such as the feeling that it is our business to defend the individual complainant against the corporations. Sympathy with the little fellow leads us often to pay particular attention to these minor, insignificant complaints.

The corporation officer can make a quick decision. He can say offhand from his general knowledge of the subject, "that is the right thing to do" and in 99 cases out of 100 he is correct. But if he has to sit down and write an opinion that might have to stand the test of the courts, it would take him perhaps a month to make a decision which now he takes but five minutes to make.

Periodical inspections of locomotives and other equipment and of track and structures are now being made, and records of train delays and locomotive failures are required by some of the commissions. A general knowledge of the conditions of the railroads is thus being obtained. This information enables many complaints to be accurately analyzed without hearings and the necessity of formal orders is largely avoided.

*Brief extracts from remarks at a Stevens Institute conference on "The Part of the Engineer in Public-Utility Regulation," Hoboken, N. J., Jan. 16, 1914.

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I think a similar system of inspection should be applied to gas and electric companies, and as far as practicable to other corporations under commission control.

Then the accident question is one that I have thought about a great deal. It is the most serious condition that the railroads have to meet, and public excitement and the tense situations thereby created are apt to result in biased reports, in the desire to hurry investigations unduly and in the making of orders affecting some elements of operation, without proper consideration of other elements which may be equally important.

I have in mind the demand for steel cars. That seems to have been almost universal in connection with recent accidents. Numbers of bills have been framed, and in some instances recommended by commissions, looking to the final replacement of all wooden cars now in service. No proper consideration is given in such proposals to the enormous cost involved, or to the increased average weight of the new equipment. The weights upon locomotive driving wheels have increased almost 40% with consequent increase in strain upon track and structures. As a result, the conditions of stress on the tracks of our railroads have grown to an amount for which there is no precedent. Over three thousand rails per year break in the state of New York alone, when the conditions are favorable. When they are unfavorable because of a severe winter, the breakage exceeds five thousand rails. Upon the divisions of some railroads carrying heavy traffic, so many breakages occur in the coldest weather as to be a serious source of delay to trains.

Now in the papers, when a rail breaks, and a serious accident occurs, you probably see that it is due to the inferior product. As a matter of fact, it is not a question of the manufacturer at all; it is a question of these severe conditions, and partly a question, possibly, of the lack of experience, a lack of fine study of all the details of the manufacture of rails and of all the elements which enter into the effect of locomotives and cars upon the tracks.

I may be much behind the times in this matter, but it seems clear to me that progress in the installation of steel cars is quick enough without legislation, and that proposals to force all wooden cars out of service are extravagant and unnecessary, and will result eventually in increased cost and diminished service to the public. Other things are needed more than steel cars, and the money available for improvements is limited. Of course, increase in safety to travel is to be strived for constantly, but we may pay too great a price for it, especially when safety in one direction may mean danger in another.

Collisions have occurred, of course, and terrible collisions, which ought not to have occurred, but what is needed is a patient study of the elements which go to prevent collisions, rather than the study of methods by which the results of those collisions can be minimized. I have in mind especially the New York, New Haven & Hartford Railroad. It seems to me that it would be a public calamity, at least for the people residing in New England, if the cars operating on every section of the lines through that locality were required to be changed to steel and the wooden cars thrown away. The wooden cars are plenty good enough for a vast amount of that service, and if heavy steel cars are required to be substituted, there probably would be only the one alternative, and that is, to diminish the service which so many of those localities need vitally.

In many sections there is need for increased local passenger service, and yet I recently heard a commissioner of one of the Western states say that he believed the time would come when legislation would, in the interest of safety, prevent the building of any but double-track railroads. He evidently did not consider that such laws would prohibit the construction of thousands of miles of light feeder lines all over the country.

One result to be hoped for from the systematic inspection of railroad lines is that when accidents occur, the commissions will be willing to bear their fair part of the responsibility and refrain from sweeping blame directed against operating officers for defects in conditions which should be detected by adequate state inspection. In common fairness also, the commissions should do all in their power to stop the demand for indictment of railroad officers in connection with accidents. All engineers who have studied the subject know that but few, if any, railroad officers, fail to recognize their duty to their fellow officers and to the public in this respect, and if their efforts sometimes fall short, it is certain to be a failure of judgment rather than any intention which can be construed as criminal. The danger of indictment, added to the severe consequences inseparable from serious accidents, will tend to drive capable men out of the railroad business.

All my study of this question of public service control has increased my belief that legislation involving details of operation should be a matter of last resort. It is too inflexible and cannot allow sufficiently for the varying conditions of service. Regulation by a fair commission is much to be preferred, and such regulation should be founded upon as complete knowledge as possible, and following constant efforts to obtain an understanding of the complex conditions involved.

I do think that it is the right and the duty of engineers to take part in the solution of these great problems. They can only be settled properly after the truth has been ascertained, and a fundamental duty in engineering is to ascertain the truth and to work in accordance with it.

There seems to be a new spirit in connection with this matter. It is not a "public be damned" spirit at all; it is the spirit of coöperation; it is the spirit of giving the community what they are fairly entitled to. In this connection I want to say that I hardly know of any improvement which is so much needed throughout this state and country as an improvement in municipal administration. I am astonished at some of the difficulties which are imposed upon public service corporations, especially upon street railroads, by the utter lack of consideration, the utter lack of general public sense of duty, I might call it, that is involved in the constitution of the average board of aldermen.

I have in mind one situation in one of the large cities where good engineering would indicate the need of straightening the lines, moving them back from one street to a nearby street, and yet it is impossible under the law for the commission to do anything to solve that difficulty. The situation as it exists now is in the hands of a local alderman and he is holding it right where he wants it and where probably he will hold it for years yet, unless the law is changed so as to take it out of his hands, or unless the city government is changed in such a way as to make individual aldermen less of a power than they are at present.

We need great improvement in the government; we need, I think, to give more honor to the men in the government. They are trying to do their duty. We need to give our governors longer terms. For instance, the commission with which I am connected has been in service six years and six months, and during that time we have had to report to five governors. No governor has a chance to become acquainted with anything like the mass of the administrative detail under his direction. He has no opportunity to go to one department and then to another and to endeavor to instill enthusiasm in it. He has to start to work, if he wants to make a record, to meet the public view and frame or recommend laws and indicate investigations, and do a vast amount of other work which he ought to take a year or two to consider before he does anything in the way of actual execution. Those are the conditions which he has to meet, and I am very glad that engineers are joining with lawyers, with business men and all others in the community, in an honest effort for their solution.

International Report on Boundary Water Pollution

A report on the field work for the investigation of the pollution of the boundary waters of the United States and Canada has just been made to the International Joint Commission of which James A. Tawney is chairman for the United States and T. C. Casgrain is chairman for Canada. The report was made by A. J. McLaughlin, surgeon U. S. Public Health Service, who served as director of the field work; John W. F. McCullough, Chief Health Officer of Ontario; John A. Amyot, Professor of Hygiene, University of Toronto; and Frederick A. Dallyn, Provincial Sanitary Engineer of Ontario. We are indebted to Dr. McLaughlin for an advance copy of the report.

The object of the field survey and report was to supply the International Joint Commission with data which will enable it to answer the first of two questions propounded to the commission by the governments of the United States and Canada. The first of these questions, and the one to which the report is addressed, may be quoted in full as follows:

To what extent, by what causes and in what localities have the boundary waters between the United States and Canada been polluted so as to be injurious to the public health and unfit for domestic or other uses?

The second question, an answer to which is not undertaken in the report, relates to remedial or preventive measures needed "to fulfill the obligations undertaken in Article IV of the Waterways Treaty of Jan. 11, 1909, between the United States and Great Britain, in which it is agreed that the waters therein defined as boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other."

The report acknowledges the assistance rendered by the United States Public Health Service, the provincial boards of health of Ontario and Quebec, the State Board of Health of Michigan, and the Department of Health of the State of New York.

The field of the investigation was extensive, but may be summarized by stating that the greater part of the work was done on the connecting rivers and contiguous ends of the lakes. The water-supply and sewage disposal of each municipality and the typhoid-death rates of many of them were investigated. Samples were collected from 1447 regular sampling points. Altogether some 19,000 samples were examined, some of them not being from the regular sampling points.

Total bacteria counts by several methods and also B. coli determinations were made. It was found that while "the great bulk of the Great Lakes water remains in its pristine purity," yet in "certain localities on the Great Lakes and in all their connecting waterways sewage pollution" exists. The "colon bacillus is practically never normally present in unpolluted waters" and the "normal total bacterial count on nutrient agar (+ 10) of the Great Lakes waters is below 10 per c.c."

The condition is far different near the cities on the lakes and in the lanes of concentrated boat traffic. Within the area investigated, every city discharges its sewage untreated into the lakes or connecting rivers and practically the same is true of the vessels on the lakes—estimated by the United States to have a population of 14,000,000 per season.

The distance that sewage pollution from the cities extends into the lakes was found to be "constantly changing, due to the currents, which are themselves dependent upon the direction and velocity of the wind." The report continues:

In two situations, at the mouths of the Detroit and Niagara rivers, serious pollution extends normally over ten miles into the lake receiving the discharge. At times it may travel much further. It was shown to travel in Lake Ontario on occasion 16 miles, and in Lake Erie 18 miles.

The distance which intake tunnels would have to be driven to reach pure water and the difficulties and cost involved in driving tunnels to the intakes and in locating intakes "below the 70-ft. depth" (which depth the report assumes to be necessary), "make it inadvisable in most instances to attempt to secure water from the lakes which would not require treatment." Furthermore, "there is not a municipality using lake water which can be said to possess a safe water-supply without treatment," yet "until very recently the use of untreated water was the rule." Continuing, the report says:

In certain localities the pollution is so great as to impose an unreasonable burden upon any known method of water purification, and where intakes are located in such localities some method of eliminating or reducing the pollution, whether from boats or municipalities, is absolutely necessary.

The report urges the folly of depending upon water-supplies which are safe the greater part of the time, but are liable to cause an epidemic like the one at Erie, Penn., in 1911. It also urges the importance of both comprehensive sanitary surveys and daily bacterial analyses, instead of depending upon occasional bacterial counts only, and being satisfied with averages, at that.

The published report will contain a mass of data for the various sampling points, the headquarters for which extended from the Rainy River at Fort Frances, Ont., and Lake Superior (Thunder Bay) at Port Arthur, Ont., through to the Niagara River at Youngstown, N. Y., and the St. Lawrence River at both Montreal and Quebec. To the Fort Francis headquarters 955 samples were taken from 192 points on the Rainy River. The greatest number of samples (1812) was taken to Detroit, Mich., from 70 sampling points on the St. Clair River and Lake, the Detroit River and Lake Erie.

NOTES

The Roadbed Suddenly Sank, at Pittston, Penn., under the weight of a Lehigh Valley R.R. locomotive and tender, on Jan. 22. According to press dispatches, the ground surface at this point is undermined by the Pennsylvania Coal Co. No one was badly injured. The locomotive and tender fell on end, a distance of about 15 ft.

Excavation in the Panama Canal still continues, but is much less than it has averaged through the past seven years. The total amount of excavation for December, 1913, was 1,581,726 cu.yd., a daily average of 60,835 cu.yd. for each of the 26 working days. The rainfall in the month was 3.57 in. In December 3144 cu.yd. of concrete were laid and 31,120 cu.yd. of fill were placed in dams.

The Metropolitan Sewerage Commission of New York, which has been investigating the pollution of the waters surrounding the city and devising plans to stop the pollution, has announced that its final report will be completed by May 1. It recommends the creation of a new commission, to be charged with the construction of remedial works, evidently in accordance with its plans. The members of the commission have tendered their resignation to Mayor Mitchel, to take effect when the report of the commission is filed with the mayor.

The Narrows Siphon, New York City—The Board of Water Supply of the City of New York received bids Jan. 27 for 9800 ft. of 36-in. submarine pipe, to be laid under the Narrows in New York Harbor, connecting the Bay Ridge Section of Brooklyn and the Borough of Richmond. The work will cost about one million dollars. Itemized bids submitted by contractors for this work will be found on p. 68 of the Construction News Section of this issue. The contract was let to the Merritt, Chapman Derrick & Wrecking Co., of New York City, for $996,862.75 on Jan. 27.

A Signal Tower Burned just outside the North Station of the Boston & Maine R.R., in Boston, Mass., on Jan. 14, causing an interruption to service. Tower A controls the eight tracks which approach the station over Drawbridge No. 1, across the Charles River. During the fire, many express trains were stalled in the train shed and incoming trains, especially locals, extended as far out as East Somerville.

The section controlled by Tower A has been divided into six sections and these have been placed in charge of the six towermen, who are, of course, familiar with these tracks. At each switch a man will be placed with the necessary flags and lanterns, for day and night signaling. Six shanties will be erected, equipped with telephones connecting with the trainmaster, who will direct the movements of the trains by these means.

The Break In the 60-In. Water Main at Rookwood Crossing, Cincinnati, on Dec. 6, 1913, which caused the death of two men, was due to the caving in of a tunnel which was being driven beneath the water main to carry a sewer 24 in. in diameter. This sewer was being constructed to drain an underpass in connection with grade-crossing elimination on the Pennsylvania R.R. The work was being done by con-

tract. The two men who lost their lives were laborers working in the tunnel. Due to the lack of auxiliary water service, the downtown or business section of the city was either without water or else had water under low pressure only, for several days. Elevators in office buildings could not be run and several manufacturing plants were forced to shut down. Besides this, the city was in grave danger through inadequate fire protection. The water-works department of the city (B. L. Baldwin, general superintendent) has under consideration measures to safeguard the water-supply in case of another accident of this kind. We are indebted to H. S. Morse, Engineer in Charge of the Division of Sewerage, of the Engineering Department of the City of Cincinnati, for the information given above.

Tests of Large Reinforced-Concrete Columns are being made by the Committee on Reinforced Concrete and Building Laws of the American Concrete Institute. The columns to be tested are 12 ft. in length and 20 in. in diameter, reinforced both with straight rods and spirals. The diameter of the shaft of the column is enlarged to 28 in. at both ends. Each end of all vertical rods was milled and fitted with an individual cast-iron base plate milled on the bottom, and care was taken to keep these bases in the same plane.

The columns were divided into the following groups: Group I, vertical steel variable; 1% spiral, no vertical steel; 1% spiral, 1% vertical steel; 1% spiral, 2% vertical steel; 1% spiral, 6% vertical steel. Group II, increasing spiral; 2% spiral, 1% vertical steel. Group III, effect of protective shell; 1% spiral, 1% vertical steel. Group IV, plain concrete. Group V, vertically reinforced columns as follows; 1% vertical steel ¼ in. diameter, hoops 12 in. apart; 2% vertical steel, ¼ in. diameter, hoops 12 in. apart; 4% vertical steel, ¼ in. diameter, hoops 12 in. apart. Concrete is mixed in the proportion of 1:1½:3.

The columns were cast in New York City as a part of a building operation going on there on Nov. 19, 22 and 26, 1913, and the tests will begin Feb. 15, 1914, at which time the concrete will be approximately 90 days old.

The Chicago Subway System for carrying street cars through the congested district, as planned by B. J. Arnold and noted in our issue of Jan. 22, has been modified somewhat in regard to the initial construction. The revised plan, as submitted to the council committee by Mr. Arnold, retains the north and south line on Clark St., but eliminates the horseshoe loop connecting with the two present river tunnels of the west side lines. For the accommodation of the west side lines he proposes a subway on Madison St., extending from Michigan Ave. to Ashland Ave. This would involve a new tunnel under the river, in addition to the two west side tunnels at Van Buren and Washington St. The two lines would be the beginning of a complete subway system, and both would be double-track lines. In the outlying districts he would provide five short tunnel crossings also (four under the river and one under a group of railway yards), to facilitate the traffic of the present surface lines. The cost is estimated at $10,478,000 for the Clark St. subway, $11,224,000 for the Madison St. subway, and $7,885,000 for the five tunnels. This amounts to $29,587,000, while it is estimated that by 1917 the traction fund will amount to about $22,000,000 in addition to which the present ordinances require the companies to spend not over $5,000,000 on the work when required by the city.

The Greater Winnipeg Water District Project is making good headway. Although it is only a few months since the report recommending the Shoal Lake supply was submitted by Rudolph Hering, Frederic P. Stearns and James H. Fuertes ("Eng. News," Sept. 25, 1913) tenders for the following preliminary work are to be received on Feb. 11: Railway track grading and laying, including clearing right-of-way; 60-lb. rails and sundries; an 85-mile telephone line; rock core drilling near the proposed Red River crossing of the aqueduct; and five residences and office buildings. Up to Jan. 20 engineers and assistant laborers had been employed in field survey and exploration and a large office staff has been working up field notes, making preliminary designs and drafting specifications. The country between Winnipeg and Indian Bay has been explored and cross-sectioned, and trial lines are being run for the aqueduct. Considerable success is being met in the effort to locate a continuous gravity flow line from Shoal Lake, the proposed source of supply, to Winnipeg. Studies of this problem will occupy the remainder of the winter. The following engineers are in charge of the five surveying parties: George F. Richan, Archie Paget, Douglas L. McLean, A. C. D. Blanchard, Charles J. Bruce. The chief of design in the Winnipeg office is Max V. Sauer. W. G. Chase, of Kerry and Chace, Toronto, Ont., is chief engineer, and James H. Fuertes, of New York City, is consulting engineer of the Greater Winnipeg Water District.

PERSONALS

Mr. Grant Davis, of Whitehouse, N. J., has been appointed County Engineer of Hunterdon County, N. J.

Mr. A. C. Adams, Superintendent of Motive Power of the Spokane, Portland & Seattle Ry., Portland, Ore., has resigned.

Mr. H. H. Sherer, recently Superintendent of Streets, Evanston, Ill., has been appointed City Manager of Glencoe, Ill.

Mr. D. E. Woozley has been appointed Engineer of Maintenance-of-way of the Union R.R., East Pittsburgh, Penn., succeeding Mr. W. S. Gibson, resigned.

Mr. D. Walker Wear, formerly with the Chicago Tunnel Co., Chicago, Ill., has been elected Vice-President of the Stow Manufacturing Co., Binghamton, N. Y.

Mr. H. R. Carter, Highway Engineer of Pulaski County, Ark., has been appointed State Highway Engineer of Arkansas, succeeding Mr. E. A. Kingsley, resigned.

Mr. W. E. Fry has been elected President of the newly organized Monarch Engineering Co., 404 White Bldg., Seattle, Wash. The Treasurer is Mr. H. D. McCleod.

Mr. Thomas E. Dwyer, a manufacturer of lead-lined iron water pipe, of Wakefield, Mass., has been appointed a member of the Metropolitan Water and Sewerage Board, Boston, Mass.

Dr. Sigismund S. Goldwater, Superintendent of the Mount Sinai Hospital, New York, has been appointed Health Commissioner of the City of New York, succeeding Dr. E. J. Lederle.

Mr. Charles W. Abbott, for many years Sales Manager of the J. A. & W. Bird Co., Boston, Mass., has resigned to accept a similar position with the Spray Engineering Co., also of Boston.

Mr. G. H. Ashman has resigned as Assistant Master Mechanic of the Juanita shops of the Pennsylvania R.R., at Altoona, Penn., to accept a position with the General Electric Co., Schenectady, N. Y.

Dr. Richard Moldenke, M. Am. Soc. M. E., has resigned as Secretary of the American Foundrymen's Association, after many years of service. It is expected he will continue to act in an advisory capacity.

Col. Wm. C. Gorgas, Assistant Surgeon General of the United States Army and Chief Sanitary Officer of the Panama Canal Zone, has been appointed Surgeon General, subject to confirmation by Congress.

Mr. P. S. Fitzgerald, for the past two years County Engineer at Moulton, Ala., has been appointed Salesman of the Troy Wagon Works Co., Troy, Ohio. Mr. Fitzgerald was with this company previous to going to Alabama.

Mr. E. E. Calvin, Vice-President and General Manager of the Southern Pacific Ry., has been elected Vice-President and General Manager of the Oregon Short Line R.R., to succeed Mr. William H. Bancroft, resigned, Feb. 1.

Mr. Erich Joseph, formerly Manager of the New York City office of Orenstein-Arthur Koppel Co., Koppel, Penn., has been promoted to be General Manager of the company, succeeding Mr. A. Reiche, resigned to accept a position in Germany.

Mr. Robert H. Lee, Assoc. M. Am. Soc. C. E., formerly Assistant Bridge Engineer, Bridge Department of Cuyahoga County, Ohio, has opened an office in the Williamson Bldg., Cleveland, Ohio, for the general practice of civil engineering.

Prof. H. E. Pressinger, of the mechanical engineering department of Marquette University, Milwaukee, Wis., has been appointed Deputy Inspector of the boiler inspection division of the State Industrial Commission of Wisconsin, at a salary of $2000 per annum.

Mr. L. B. Allen, Engineer of Maintenance-of-way of the Chesapeake & Ohio Ry., at Covington, Ky., has been promoted to be Assistant Chief Engineer at Richmond, Va., succeeding Mr. W. F. Steffens, Assoc. M. Am. Soc. C. E., resigned, as noted in our issue of Jan. 8.

Mr. Robert D. Gray, of Katalla, Wash., has been appointed Receiver of the Alaska-Pacific Ry. & Terminal Co. The company was organized eight years ago to build a railway into the Bering River coal fields of Alaska, but the work has been held up by Federal legislation.

Mr. A. B. Newell, former President and General Manager of the Tennessee Central R.R., Nashville, Tenn., has been elected President of the Toledo Terminal R.R., Toledo, Ohio. From 1901 to 1905 Mr. Newell was Vice-President and General Manager of the White Pass & Yukon Route, in Aaska.

Mr. S. G. Pollard, M. Am. Soc. M. E., of Pollard & Elms, Consulting Engineers, Cincinnati, Ohio, has been appointed by City Manager H. M. Waite, of Dayton, Ohio, to make a systematic survey of the Dayton water-works. Mr. Pollard was formerly Superintendent of the pumping department of the Cincinnati water-works.

Mr. Frank S. Krug has been appointed City Engineer of Cincinnati, Ohio, succeeding Mr. H. M. Waite, recently elected City Manager of Dayton, Ohio. Mr. Krug is a former County Engineer, and at the time of his appointment as City Engineer was Secretary and Assistant Treasurer of the Kirchner Construction Co., Cincinnati.

Mr. G. C. Cummin, who resigned as City Engineer, of Dayton, Ohio, in May, 1913, in order to devote his whole time to flood rehabilitation and flood-prevention work, has been reappointed City Engineer. Mr. C. H. Kline, who has been acting City Engineer, returns to his former position as Engineer of the Water Department.

Mr. William A. Baldwin, recently Superintendent of the Delaware and Jefferson divisions of the Erie R.R., at Susquehanna, Penn., has been promoted to be Assistant General Superintendent of the Erie grand division, at New York City. Mr. Baldwin is a former Division Engineer of the Erie. He was educated at Cornell University and joined the engineering corps of the Erie R.R., in 1896, as a rodman. In April, 1909, he left the engineering department to become a Division Superintendent.

Mr. Robert P. Howell, M. Am. Soc. C. E., whose election as one of the Commissioners of Phillipsburg, N. J., was noted in our issue of last week, has been made Director of Streets and Public Improvements and Town Engineer. Mr. Howell was not Town Engineer at the time of his election, as stated in last week's issue, but had been for several years previous to January, 1913. The statement that he had also served as inspector of water-pipe and castings at the Warren Foundry was erroneous and should have referred to Mr. Oscar Bates, another of the newly elected commissioners.

Mr. H. Bortin, Assoc. M. Am. Soc. C. E., has resigned as Assistant Engineer in charge of the valuation department of the Union Pacific R.R., and as a member of the company's valuation committee, to become Assistant to the General Secretary of the Presidents' Conference Committee on the valuation of the railways of the United States. His headquarters will be in the Broad St. Station, Philadelphia, Penn. Before his work with the Union Pacific R.R., Mr. Bortin was with the engineering staff of the Isthmian Canal Commission in Panama, where for two and a half years he was engaged in municipal and hydraulic engineering work. He is succeeded on the Union Pacific R.R. at Omaha, Neb., by Mr. G. P. Turner, as noted in our issue of last week.

Mr. George H. Bremner, M. Am. Soc. C. E., recently Engineer of the Illinois district of the Chicago, Burlington & Quincy R.R., has been appointed Assistant District Engineer of the Chicago district for the Interstate Commerce Commission valuation of railways. Mr. Bremner graduated from the University of Iowa in civil engineering in 1883. He had previously served as a draftsman with the Chicago, Burlington & Quincy R.R. Following his graduation he began as a rodman on the construction of the Chicago, St. Paul & Kansas City Ry. In September of the same year he was made transitman on maintenance-of-way on the Chicago & Northwestern Ry. The next spring he entered the service of the Chicago, Burlington & Quincy R.R. as a transitman on preliminary surveys, and he has since been continuously in the service of this railway and its subsidiaries. He was successively promoted to be draftsman in the construction department, Division Engineer of Maintenance-of-way, and District Engineer.

Mr. John Wilson has resigned as City Engineer of Duluth, Minn., owing to what he believes to be unjust and malicious criticism of his department. In his letter of resignation are several points well worthy of consideration by the general public as well as by other engineers:

> When a technical man engages in municipal work he must expect to have his work passed upon by a public for the most part unqualified to do so; but from whom helpful suggestions may be received, as well as many impossible demands. When these suggestions or demands assume a malicious nature, the outgrowth of ulterior motives, and an official is unable to command considerable public support, the situation becomes difficult indeed, not only for himself, but also those responsible for his appointment. * * * *
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> In leaving the service of the city I have no apologies to make for the work done under my direction. In so far as matters have been within my power I have acted on the merits of the questions under consideration, without attempting to incur special favor of any one.
>
> As to those now in my department whom I shall leave to my successor, I have only words of commendation. They need sympathetic support and encouragement rather than continual criticism.

OBITUARY

Edward W. Chadwick, Superintendent of the Carolina R.R., Kinston, N. C., died Jan. 20, aged 43 years.

Gregory Heine, a retired builder and contractor of Reading, Penn., died on Jan. 20, at the age of 89 years.

Stephen T. Williams, head of Stephen T. Williams & Staff, Inc., Efficiency Engineers, New York City, committed suicide on Jan. 15.

Isaacs Richards, Director and Consulting Engineer of the Otis Elevator Co., of Philadelphia, died at his home in Morristown, Penn., on Jan. 20. He was born in Finesville, N. Y., in 1848.

Benjamin Osgood Pierce, Hollis Professor of Mathematics and Physics, at Harvard University, died at his home in Cambridge, on Jan. 14, at the age of 60 years. He had taught for 38 years.

John C. Kelly, founder and for the past 44 years President of the National Meter Co., died at his home in Brooklyn, N. Y., on Jan. 24. Mr. Kelly was a charter member of American Water-Works Association and attended the annual meetings of that body for the past 30 years. He was born in Woodstock, Ireland, on Apr. 17, 1839.

Ulysses S. Lutz, M. Am. Soc. C. E., Assistant Engineer, in the Finance Department of New York City, and active in early railroad location and construction work, died at his home in New York, on Dec. 8, 1913. Mr. Lutz was born in Philadelphia, Penn., on May 25, 1853, educated at the Polytechnic Institute there, and began railroad work as a rodman on the South West Pennsylvania R.R.

Donald Alexander Smith, Lord Strathcona and Mount Royal, Hon. M. Can. Soc. C. E., died at his home in London, England, Jan. 21, in his 94th year. His name is best known among engineers as a pioneer promoter of Canadian railways, and when it is remembered that he was born in Scotland in 1820, several years before railways came into use in Great Britain, the Canadian railway development in which he played so important a part, has been truly wonderful. At 18 years of age he left his home to enter the service of the Hudson Bay Co. in Canada, where for many years he was exiled to the wildest and most unknown parts of the Canadian wilderness. He advanced steadily in the service of the fur company until he became its head. He was among the first to see the need of a Canadian transcontinental railway and to him more than any other one man was due the success of Canadian Pacific Ry. Previously he had added greatly to his fortune by participating with Mr. James J. Hill in the organization and development of what became the Great Northern Ry. He subsequently became prominent in Canadian politics and for many years had been High Commissioner for the Dominion of Canada at London.

ENGINEERING SOCIETIES

COMING MEETINGS

NATIONAL LIME MANUFACTURERS' ASSOCIATION.
Feb. 4-5. Annual meeting at New York. Secy., Fred K. Irvine, Chicago, Ill.

IDAHO SOCIETY OF ENGINEERS.
Feb. 5-7. Annual convention at Boise. Secy., I. F. Shaffner, Boise.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb. 10-11. Annual meeting at Hartford, Conn. Secy., J. Frederick Jackson, Box 1304, New Haven, Conn.

OHIO ENGINEERING SOCIETY.
Feb. 11-14. Annual meeting at Columbus, Ohio. Secy., D. W. Seitz, Columbus, Ohio.

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.
Feb. 12-14. Meeting at Chicago, Ill. Secy., J. P. Beck, 72 W. Adams St., Chicago, Ill.

NORTH DAKOTA SOCIETY OF ENGINEERS.
Feb. 12-13. Annual convention at Fargo, N. D. Secy., E F. Chandler, University of North Dakota, University, N. D.

AMERICAN CONCRETE INSTITUTE
Feb. 16-20. Annual meeting in Chicago, Ill. Secy., E. E. Krauss, Harrison Building, Philadelphia.

IOWA ENGINEERING SOCIETY.
Feb. 18-20. Annual meeting at Council Bluffs, Iowa. Secy., S. M. Woodward, Iowa City, Iowa.

MINNESOTA ENGINEERS' AND SURVEYORS' SOCIETY.
Feb. 24-25. Annual meeting at St. Paul, Minn. President, Wm. Danforth, 411 Hackney Building, St. Paul, Minn.

INDIANA SANITARY AND WATER SUPPLY ASSOCIATION.
Feb. 26-27. Annual meeting at Indianapolis, Ind. Secy., Dr. W. F. King, Indianapolis.

HIGHWAY ENGINEERS' ASSOCIATION OF MISSOURI.
Feb. 26-28. Annual meeting at St. Joseph. Secy., Ray L. Gargill, St. Joseph, Mo.

ILLINOIS WATER-SUPPLY ASSOCIATION.
Mar. 9-11. Annual meeting at Urbana, Ill. Secy., Edward Bartow, Urbana, Ill.

NEW ENGLAND RAILROAD CLUB.
Mar. 10. Annual meeting at Boston. Secy., Wm. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 17-20. Annual convention at Chicago. Secy., E. H. Fritch, 900 S. Michigan Ave., Chicago, Ill.

Michigan Engineering Society—The 35th annual meeting was held at the Michigan Agricultural College, East Lansing, Mich., Jan. 13 to 15. The arrangements were in charge of Prof. Arthur J. Decker, of the University of Michigan, owing to the recent death of Mr. Holmes, who had been secretary of the Society for a number of years.

The papers presented included the following: "Machine Design and Construction at the Michigan Agricultural College," C. J. Kanz; "The Industrial Law from the Employers' Standpoint," C. E. Bement; "Engineering Practice in Turkey," John R. Allen; "The Sewage Disposal Plant at Sturgis, Mich.," H. C. Sherman; "The State Board of Health and the Grand Rapids Decision," W. C. Hoad; "Sanitary Conditions in Michigan Cities and Villages," H. F. Vaughan; "Flood Protection in Ohio," W. J. Sherman; "Surveys for Highways," L. D. Townsend and H. L. Brightman; "Concrete," E. F. Smith; "Tests of Paving Materials," H. B. Pullar; "Problems in City Paving," A. Lenderwick; "The Valuation of Public Utilities," Hon. L. T. Hemans; "Excavation in Quicksand," W. W. Brigden; "The Topographical Survey of Michigan," R. C. Allen; "Land Surveying," A. N. Bateman.

The annual dinner was held, and there were visits of inspection to points of interest. The officers elected for 1914 are as follows: President, J. J. Cox, Ann Arbor, Mich.; Vice-President, D. E. Teed, Cadillac, Mich.; Secretary, S. J. Hoexter, Ann Arbor, Mich.

Albany Society of Civil Engineers—The annual dinner and meeting was held at Keeler's Hotel, Albany, on Jan. 27. The officers elected for 1914 were: President, Frank R. Lanagan; 1st Vice-President, Harvey O. Schermerhorn; 2d Vice-President, John E. Byron; 3d Vice-President, Rupert Sturtevant; Secretary, Ernest G. Raynor; Treasurer, Edward H. Sargent.

American Institute of Consulting Engineers—At the annual meeting following the usual monthly dinner held in New York City on Jan. 20 formalities were gone through by which the property of the Institute as originally organized was transferred to the American Institute of Consulting Engineers, Inc. A new council was elected, the work of the past year was reviewed and various committee reports were presented.

President Noble outlined the efforts made by a committee to bring to the attention of various appointing authorities the desirability of appointing engineers on various Federal, state and municipal public commissions, or as head of various departments. Acting with committees from other engineering societies a successful campaign was made against the efforts of a secret society to get through the New York Legislature a bill for licensing civil engineers. A joint committee representing five or six national engineering societies is now at work and has practically completed the framing of a bill for the registration rather than the licensing of engineers. On completion of the draft of the bill it will be reported to the several societies and the work of the joint committee will cease.

In conclusion Mr. Noble said a few words regarding the standing of the Institute. As reasons in favor of confining the membership of the Society to a relatively small number of competent engineers, he remarked that no other society could have done as much effective, disinterested work as did the Institute during the past year. The report of E. W. Stern, secretary and treasurer (101 Park Ave., New York City), showed that the membership of the Institute had increased from 62 to 70 during the year. Five meetings were held with an average attendance of 23. There were eleven meetings of the council with an average attendance of four. A small cash balance was in hand at the end of the year besides a considerable sum of money invested in bonds.

There were various other committee reports, but final action was not taken on any of them.

The canvass of ballots for members of the council of the American Institute of Consulting Engineers, Inc., showed that the following had been elected: Alfred Noble, New York, E. C. Shankland, Chicago, and Frank J. Sprague, New York, for one year; Henry Holgate, Montreal, Daniel E. Moran, New York, and Charles Sooysmith, New York, for two years; Elmer L. Corthell, New York, Henry W. Hodge, New York, and Jonathan P. Snow, Boston, for three years.

American Water-Works Association, New York Section—Acting under authority granted by a recent revision of the constitution of the American Water-Works Association nearly a hundred members and guests of the Association in New York and vicinity met at lunch in New York City on Jan. [illegible] and subsequently organized a New York Section. A very simple form of constitution was adopted, which provides that the affairs of the section shall be administered by a committee of five, which shall select from its members a chairman and secretary for the section. The terms of service of the first committee will range from one to five years each, as determined by lot. The successors to these members of the committee will be elected for terms of five years. The composition of the first committee is as follows: Allen Hazen, J. Waldo Smith, Robert Milligan, and Henry De Forest Baldwin, all of New York City, and Morris Sherrerd, Newark, N. J. Members of the American Water-Works Association resident in New York and New Jersey are eligible to membership in the New York section. To join the New York section membership in the Association is necessary. The section expenses up to 25% of the annual dues of section members are met by the parent Association. It is hoped that sections will be organized in other parts of the country.

After the business of the meeting had been transacted George W. Fuller, consulting engineer, of New York City, presented a verbal abstract of a long paper which he had written for the section. The paper reviews in much detail the history of efforts to secure the filtration of the Croton water-supply of New York City. In opening his remarks, the speaker stated that in Germany there is a well followed unwritten rule to the effect that all surface waters shall be filtered. The operation of filter plants is under the supervision of the Imperial Government. Much the same rule as to filtration is followed in Great Britain. The speaker was of the opinion that the rule should also be adopted and followed in the United States.

A movement for purer water in New York City began some twenty years ago. The first action was the purchase of a large amount of land in the Croton drainage area, at an expense of perhaps five to six million dollars. Agitation for the filtration of the Croton water-supply has been going on for the past fifteen years. The greater part of Mr. Fuller's talk reviewed the filtration projects, plans and bids which were explained and discussed at some length in our issue of May 22, 1913, and subsequent issues about the time that the project was killed by the Board of Estimate and Apportionment. At the conclusion of Mr. Fuller's remarks, Allen Hazen, the chairman of the meeting, said that while the project is dead the subject is still a live one. Then he called on D. V. French, of the Hackensack Water Co., Hoboken, N. J., to give his experience with the filtration of water similar to the Croton, asking him to state whether or not filtration paid in his case. Mr. French responded by saying that his company never did anything of more value to water consumers than when it built the filtration plant eight or nine years ago. He thought the company was to be congratulated for having built the plant at its own volition instead of being forced into it by a typhoid outbreak. The cost of filtration has been about $5.50 per million gallons, not including capital charges, and a population of some 400,000 is being supplied with filtered water.

Prof. Wm. P. Mason and John M. Diven, of Troy, N. Y., being called upon, remarked that filtration was needed at Troy, but could not be afforded at present; or, in other words, that the city must obtain more water, or at least build a new pipe line to convey water to the city, before attempting filtration. Mr. Diven thought that the citizens of Troy are paying $75,000 a year for bottled water. If filtered water were to be introduced it would be necessary to train the people to give up bottled water for the filtered water after having used the former so many years.

Nicholas Hill, Jr., of New York City, indorsed what Mr. Fuller said regarding the desirability of filtration for New York City. He added that while filtration is not absolutely imperative, it is highly desirable that the water should be filtered and that the construction of a filtration plant should be begun as soon as possible. Frank E. Hale, chemist, of the Mt. Prospect Laboratory, Department of Water Supply, Gas and Electricity, New York City, reviewed the various means that are now being taken to protect the quality of the Croton water-supply. He stated that typhoid fever in the Croton drainage area is recorded so far as possible and investigated, and the excreta from the case disinfected. A staff of some twenty-five to thirty sanitary inspectors is at work in the Croton drainage area all the time, and occasionally some sixty to seventy special inspectors are sent there. Water closets on trains passing through the drainage area are closed. Railway-bridge floors over streams in the Croton drainage area are made solid to protect the water-supply from pollution. Several small sewage-treatment plants and the whole Croton supply is disinfected by hyprochlorite (described in "Engineering News" of Feb. 27, 1913.)